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SYMPOSIUM: The Role of the Medical Technologist in an Atomic Disaster

General Remarks on the Professional Problems Involved

By *ELLEN SKIRMONT, M.T. (ASCP) B.A.

Devastation caused by floods, earthquakes, and hurricanes is small compared with that which would be left following an atomic disaster. Just as certain areas are prepared to handle emergencies due to these natural phenomena today, we must learn to face the hazards of an atomic bombing in metropolitan areas. To meet this new danger preliminary steps can be taken now to educate the public so that mass hysteria and panic are avoided. The civilian defense problems will be the same on the whole, whether this be an ordinary bombing raid or an atomic bombing. Cooperation and a background of essential knowledge and training can do more than anything else to strengthen our civilian defense lines which may mean our survival. Medical Technologists must be a strong link in the chain of preparedness.

The atomic bomb is a new weapon of great destructive power. But it differs from other bombs in three important respects; first, the blast effect of an atomic bomb is a thousand or more times as great as that produced by the most powerful TNT bombs; second, the explosion of the bomb is accompanied by highly penetrating and deadly invisible rays in addition to intense heat and light approaching that of the sun's interior; and third, the substances remaining after the explosion are radioactive, emitting radiations capable of producing harmful consequences in living organisms. It is on account of these differences

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* Author wishes to acknowledge the assistance of Dr. Leon O. Jacobson in the preparation of this paper.

that the effects of the atomic bomb will be responsible for the high number of casualties found in a city target area.

No accurate estimate can be made of the number of casualties that might occur since the number is dependent upon so many factors, such as the type of burst; whether it is air, ground, or underwater; type of construction of the city; season of the year; density of the population; and the time of day the detonation occurs. The injurious effects resulting from an atomic explosion would be of three types: these are blast injuries, burns, and radioactivity injuries. Each of these is distinct and can be considered separately.

The greatest attention should be given to a defense against high air bursts, since they cause the greatest general damage and probably produce the largest number of casualties in a city. Directly beneath the bomb's target and within a radius of one-half mile all individuals would be killed and everything demolished. In a radius of one-half mile to a mile from target center additional deaths would occur and the majority would receive injuries of varying severity. Personnel located between one and two miles of the center would receive injuries from flash burns and indirect blast effects. Outside this two-mile limit and within a four-mile radius flying fragments would account for many superficial wounds. There are two types of blast casualties, direct and indirect effects. The direct effects are caused by a sudden increase of pressure on the body causing injury of the lungs, stomach, intestines, and ear-drums and causing internal hemorrhage. Indirect blast effects are due to collapsing buildings and flying debris. Injuries vary from complete crushing, severe fractures, and lacerations to minor scatches and bruises. Traumatic shock is a serious complication in many cases.

Flame and flash burns will account for a large share of injuries. Flame burns are those sustained as a result of secondary fires, which result from short circuits, exploding gas mains, and other similar causes. Flash burns will result from direct exposure to the intense ball of fire. This intense flash produces two hazards—temporary blindness and flash burns. The number of flash burn casualties will also depend upon several factors. The season of the year is of importance as in the winter, inhabitants of temperate zones are more likely to be covered with heavy clothing that would greatly reduce the number of burns. The time of day is a big factor. During rush hours many more persons will be exposed than during the early morning. Fog, haze, or rain would greatly reduce the radius of flash heat effects. For emergency treatment it isn't necessary to distinguish the types of burns, the treatment will be the same. The unique feature of the atomic bomb is the great number of casualties produced in a very brief period of time.

The only nuclear radiation hazard associated with a high air burst is direct exposure to the radiations of gamma rays and neutrons, which are emitted during the first ten seconds after the explosion. Most of the neutrons are slowed down and absorbed before they reach the ground and are carried aloft in the mushroom cloud. Only at points near the direct target would the effects be lethal. In a single explosion the atom splits in a number of different ways causing the formation of nearly 160 types of fission products, all of which are radioactive, emitting gamma rays and beta particles, for a short or long time, depending on the particular fission product. Hence, delayed radiations would come from the gamma rays and beta particles emitted by these fission products after the explosion.

Radioactivity affects the human body by a process of ionization. Different types of radiation vary in their capacity to cause ionization. The alpha particles do not penetrate the horny layers of skin and are only harmful when ingested or introduced through breaks in the skin. Beta particles are also most dangerous when inside the body. Gamma rays and neutrons are definite external hazards as they are able to penetrate the body, they constitute the chief radiation danger in an air burst. It must be remembered though that all types of radiation produce identical biological effects that vary only in a quantitative manner. The most characteristic changes are those that take place in the blood. Ionization from any radioactive ray or particle may cause irreparable or transitory damage to cells depending on the degree of dosage and the sensitivity of the irradiated tissue. The various tissues in the body differ markedly in their susceptibility to radiation. The reduction in the natural protective mechanisms of the body to increased infection following irradiation may lead to epidemics in an atomic disaster. Another aspect of radiation sickness is its preventive action in the healing of burns and lacerations. Frequently, insignificant burns or lacerations that appear to be healing well may break down and become infected due to the complicating effects of the radiation syndrome.

In an air burst the bomb is detonated at optimal height to cause maximal blast damage. An explosion at ground level would produce fewer casualties from blast or burns, but a small area would be highly contaminated with radioactive material. This type of contamination will certainly make evacuation and fire control more hazardous. In the event of an underwater burst the blast and burn casualties would be diminished. This type of burst presents primarily a radiation hazard. While one cannot foresee the number of casualties resulting from such a situation the medical problem should be much less acute.

But what has the make-up of the atomic bomb to do with medical technology? Are we as medical technologists required

to be familiar with the jargon of neutrons, beta particles, gamma rays, etc., in order to cope with atomic casualties? Yes, to a certain extent because as professional medical technologists we are concerned with the cause and effect of disease, injury, or any bodily abnormality. Again there is another reason why we should have a sound background in the principles of an atomic explosion and its medical effects. This may sound like heresy, but there will be no time for certain ethical considerations in an atomic attack. Inevitably, the nurses and medical technologists will be called upon to assume many of the functions of doctors, and in order to do this effectively, as well as exercising their own professional function they must be well-oriented to the atomic situation. As our country's civilian defense plans gather impetus under the atomic threat, the medical technologists with other medical personnel are beginning to sense the responsibility that will be theirs in the event of an atomic attack. The medical branches of civilian defense organizations are including the registering of technically-trained people. Our services have been offered as an organization to the national authorities while many of the state groups have been actively engaged for months. With the publication of the government manual "Health Services and Special Weapon Defense" the medical personnel are at last provided with an over-all plan on personnel training, stockpiling of supplies, etc. There is no longer an excuse for states and communities to delay action, nor is there any valid excuse for active or inactive medical technologists to hold back from volunteering for civil defense work and enrolling in many of the first aid courses that are being offered by the American Red Cross.

Should an atom bomb ever go off over an average American city, it is estimated that there would be 120,000 casualties, of these 33.5% would be killed outright or die within a short period of time, thus 80,000 casualties would survive the blast and would be in need of some medical care. Of the 80,000 casualties; 70% would be wounds; 65-85% burns, and over 30% radiation injury. These percentages total over 100% because a great number of persons would have two or more types of injuries. An atomic burst over a heavily populated area would cause so much physical destruction and so many casualties in the personnel of the local civil defense organization that they would be unable to function efficiently and civil defense activities would have to be carried out by personnel and supplies arriving from the outside. This means that each area and community, according to its medical resources, must be ready to contribute to the total civil defense needs of the country.

The present supply of doctors, nurses, and medical technologists in many metropolitan areas barely covers the health needs of the inhabitants today; imagine, then, the tremendous task of

an atomic-struck city in coping with thousands of emergency casualties. The magnitude of the situation makes it difficult to comprehend and almost impossible to visualize. As manpower is a critical item women should be trained and employed to the utmost extent in all medical activities in civil defense. What will the role of the medical technologists be? With some 80,000 injured persons in need of immediate medical attention, it becomes almost impossible to do anything else but to give simple first aid and quick transfusions of blood and plasma and other body fluids. Her greatest role in the first 48 hours of a disaster would be typing and cross-matching blood. Medical technologists could be trained to administer plasma for certainly there won't be enough doctors and nurses to administer all the plasma needed—a medical technologist who already knows how to do venous punctures would be the most logical person to train. Antibiotics and tetanus antitoxin will be given as a precautionary measure and she certainly should know how to inject these substances. The medical technologist will play an important part behind the scenes and will carry great responsibility under the exreme pressure of emergency.

Today, doctors place a tremendous burden upon the laboratories when treating severely burned patients or severe fractures and wounds. Multiply these demands by thousands in the event of an atomic disaster—these casualties will be the same type and will demand the same type of treatment and the burden in the laboratory will be just that much greater.

There will be thousands of persons who will live beyond the first hours of the attack that will have been hit by the invisible rays and will begin to develop radiation sickness. But before the doctors will be able to treat these victims of atomic radiation skilled medical technologists will first have to establish the extent of the hidden changes upon the blood and tissues. Thousands of white blood counts and differentials must be studied, due to the shortage of skilled help perhaps it would be best to limit erythrocyte counts to only hematocrits and hemoglobins.

As medical technologists it is our civil responsibility to familiarize ourselves with the problems associated with the possibility of an atomic disaster, and it is in national interest that we be as well-prepared and informed as possible in order that we may carry out our duties to the best of our abilities.

BIBLIOGRAPHY

Cooney, J. P., March 1951. The doctor's problem in atomic warfare. J. Am. Med. Assoc.

"The Effects of Atomic Weapons," June 1950. U. S. Scientific Laboratory, Los Alamos, New Mexico.

SURVEY HEMATOLOGIC STUDIES AND THEIR SIGNIFICANCE

By *EVELYN O. GASTON, B.S.

The atomic bomb produces intense radiations that are highly penetrating and can produce harmful effects in living organisms. Since large, acute doses have been sustained by human beings only as a result of accidents, our information is based largely on observations made following the explosions at Hiroshima and Nagasaki, and on results obtained from experiments with animals whose sensitivity to radiation relative to that of human beings has been studied in our laboratory and elsewhere.

It has been found that the blood and blood-forming organs are among the most sensitive of the body to penetrating radiations. We must, therefore, be familiar with the changes that may occur in the blood and be prepared for the emergency of an atomic explosion by having available sufficient standard hematologic equipment.

Total-body exposure to 400 to 600 roentgens produces severe anemia, leucopenia, and thrombocytopenia.[1] Peripheral blood counts of animals exposed to semi-lethal doses of radiation show rather similar changes without regard to species and are sufficiently similar to those changes observed in the human being that have been thoroughly studied to make extrapolation possible.[2] The most sensitive indicator of radiation damage soon after exposure is the reduction in the lymphocyte count.[3] With semi-lethal doses the number of lymphocytes drops rapidly, reaching a maximum depression in 48 hours. Recovery is extremely slow, requiring 50 or more days. (Fig. 1). If no significant decrease in the number of lymphocytes is detected by 72 hours after exposure, it is currently believed that no serious radiation damage will result. This does not imply, however, that late changes such as an increased tumor incidence, cataracts, and the like, may not occur. Frequently there is an initial transient leucocytosis (in excess of 10,000 per cu.mm.) that is due apparently to an increase in the granulocytes. This has been demonstrated in rabbits[3] and was also reported in human beings in Japan following the atomic explosion.[2] However, a sharp reduction in the granulocytes occurs after this initial rise with recovery by 26 or more days. This observation—namely a leucocytosis within the first 24 hours that is due to an increase in the circulating granulocytes—is one of the most important facts to

* Author wishes gratefully to acknowledge the guidance and cooperation of Dr. Leon O. Jacobson in the preparation of this paper.

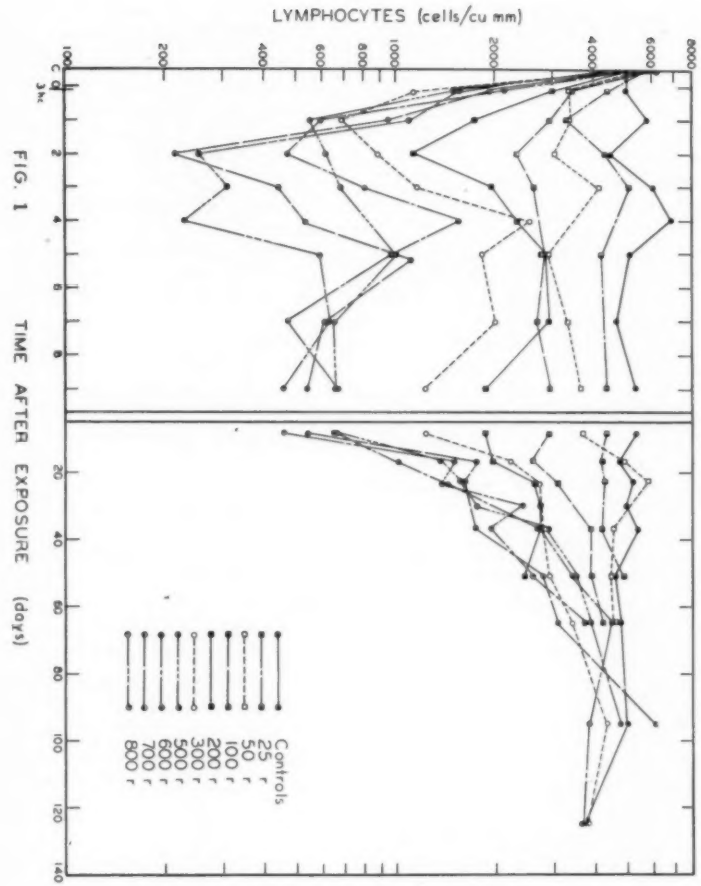


FIG. 1

bear in mind, since within the first day after such exposure a diagnosis of severe radiation injury, based on the white count alone, is not possible—a lymphopenia is actually the single criterion. This makes either a smear or a chamber differential a necessity if diagnosis is essential during the first 24 hours after exposure. Leucopenia becomes of diagnostic significance on about the third day. The total white count remains depressed for

about one week, then slowly rises and returns to normal in three to six weeks (Fig. 2). At present the white blood cell count is

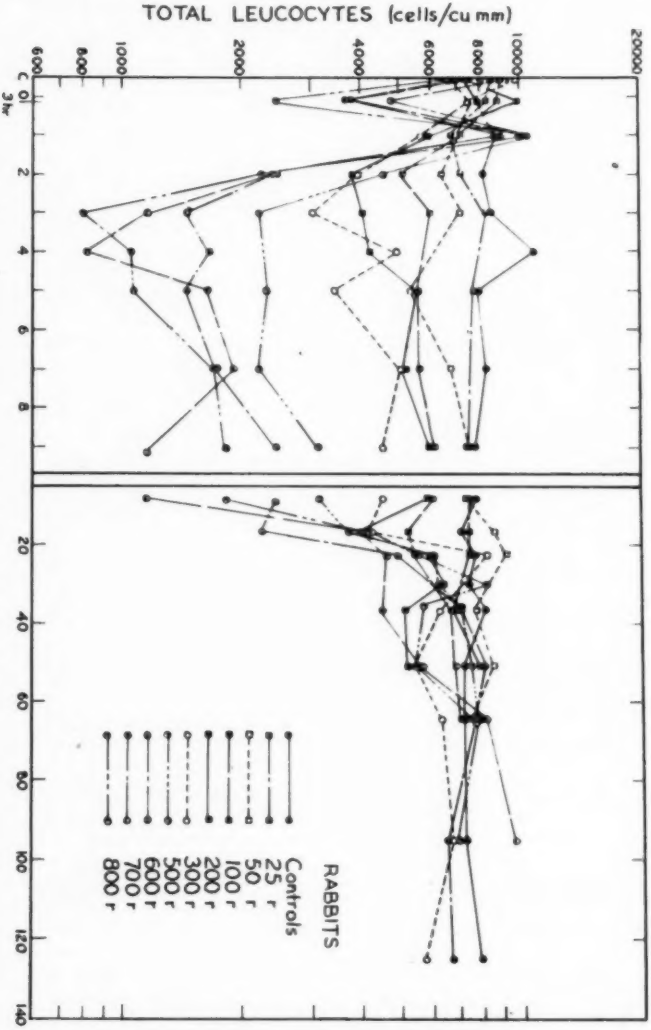
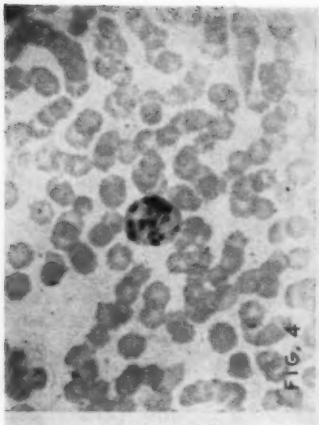


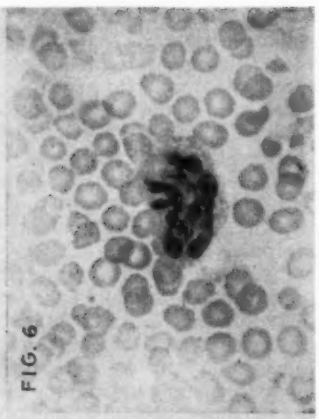
FIG. 2

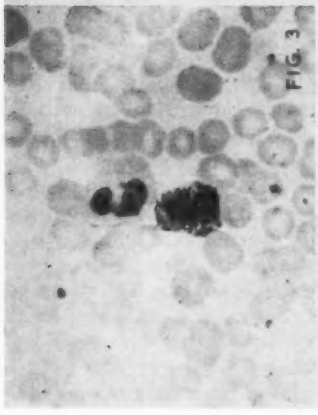
considered to be the most valuable and direct single index of radiation sickness. Although various infections also cause similar blood changes it is not likely that they will cause confusion, if, after an atomic explosion, a suspected group of individuals shows substantial reductions in the leucocyte counts.[3]

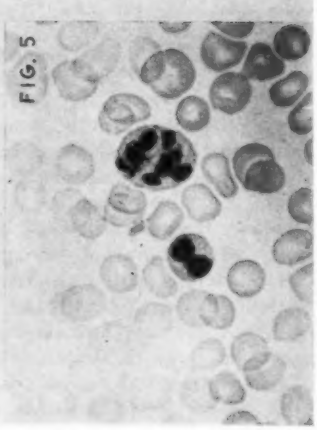
The damage caused by radiation is apparent in the individual blood cell and can be detected from a blood smear stained with Wright's stain. It is absolutely necessary that the blood smear be stained properly and that it be thin so that the structure of the nucleus and cytoplasm can be studied. The nucleus of many lymphocytes is irregular or bilobed with deep and pale staining areas and with clumping of the chromatin which gives a blotchy appearance to the nucleus. Other leucocytes have the appearance of lymphocytes that contain round or rod-shaped bodies within the cytoplasm and could be atypical monocytes. Mitotic blast forms also may appear after semi-lethal or higher doses. The most consistent morphological abnormality in the granulocyte of the peripheral blood is the appearance of toxic non-specific basophilic granules of uneven contour that fill the entire cell. These cells which appear as early as three days after acute radiation exposure and often persist for several months are difficult to distinguish from true basophils (Fig. 3). During the phase of rapid reduction of the granulocytes abnormal forms are seen with nuclear deformity and disintegration to the extent that it is impossible to determine at which stage of maturity the cells are damaged (Fig. 4). Neutrophils as well as eosinophils frequently contain vacuoles and are giant in size with multilobed nuclei (Figs. 5, 6). At the time when the leucocytes are showing an increase, the red cell count and hemoglobin are reduced, especially when radiation damage is high. A marked anisocytosis often develops with an increasing number of nucleated red cells. Reticulated erythrocytes are reduced to less than 0.1 of one per cent by three days and remain thus reduced for one week reaching normal values by 23 days.

The platelet values are comparable with the granular cells in their sensitivity to radiation, except that their maximum reduction is reached later (eight days) and recovery begins somewhat earlier. At the time of maximum reduction of platelet values, giant platelets are found in the blood smear of the peripheral blood, and on rare occasions megakaryocytes are present (Fig. 7). These data are general in character and furnish no reliable criteria for prognosis or diagnosis of individual cases, since marked variations in radiosensitivity exist among individuals. Neither do they cover the hazards of chronic radiation, the residual radiations that are due to fission products that remain









after the initial atomic blast. It is unlikely that, following such an unhappy emergency as an atomic blast, extensive hematologic studies will be possible. The work of technologists will be coordinated with the over-all medical effort and will be dictated by the varying needs that arise in establishing a diagnosis or a basis for therapy.

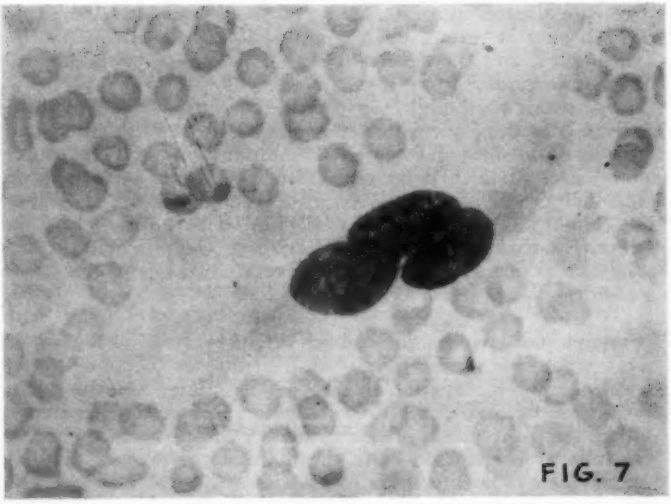


FIG. 7

LITERATURE CITED

1. Jacobson, L. O., R. S. Stone, and J. G. Allen. 1949. Physicians in an atomic war. J. Am. Med. Assoc., 139:138-140.
2. LeRoy, G. V. 1950. Hematology of atomic bomb casualties. Arch. Internal Med., 86:691-710.
3. Jacobson, L. O., E. K. Marks, and E. Lorenz. 1949. The hematological effects of ionizing radiations. Radiology, 52:(3)371-395.

SPECIAL STUDIES ON BLOOD COAGULATION

By *M. H. SANDERSON, M.T. (A.S.C.P.) B.S.

All of you who read John Hersey's book, "Hiroshima," will recall his vivid descriptions of the massive hemorrhages experienced by many of the victims after the bombing of that city. Radiation emitted by the bursting of the bomb produced profound changes in the clotting mechanism of these people and their blood would not clot. Hence, many of them were said to have actually bled to death.

This same bleeding tendency can be produced in dogs and other laboratory animals by subjecting them to sub-lethal as well as lethal doses of X radiation. It robs the animal of much needed

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* Author wishes to acknowledge the assistance of Dr. Leon O. Jacobson in the preparation of this paper.

red cells, causes discomfort, and retards recovery. If the hemorrhagic disease is severe, it, in combination with leucopenia, lack of antibodies, and the resultant inability to cope with infection, will most certainly prove fatal.

The onset of the hemorrhagic phase of radiation sickness is in the second to third weeks after exposure in humans and on the eighth to eighteenth days in experimental animals. The sites of hemorrhages are nearly as numerous as the various structures of the body. The size varies from petechiae and ecchymoses to large hematomata, which may contain nearly half the blood volume. Gastro-intestinal hemorrhage is a common complication.

The causes of hemorrhage may be related to one of the following abnormalities that may develop:

1. **Platelet reduction.** The platelets decrease slowly for the first week following radiation. During the second week a frank thrombocytopenia develops with platelet counts under 40 thousands per cubic millimeter. The thrombocytopenia persists either until the death of the animal or, if the animal survives, for four to five weeks, when the platelet count rises gradually and usually is within the lower limits of normal by the 30th to 60th days after irradiation. The role of platelets in the initiation of clotting is well documented. The technics involved in counting platelets need not be mentioned here.

2. **The presence of a circulating heparin-like anticoagulant,** the source of which in the body is unknown. This hemorrhagic syndrome may be found even when other known constituents concerned with preservation of normal clotting are within normal limits. In a previous presentation before this society the technics used in the diagnosis of this syndrome were described. They consist of the determination of the modified Lee-White clotting time and the protamine titration. Normal values for the human for these tests are 30 to 40 minutes for the clotting time and 120 micrograms of protamine sulfate.

3. **Increased capillary fragility.** The widespread petechial hemorrhage and ecchymoses that characteristically develop in individuals or animals subjected to high dosages of radiation may be related to the presence of a circulating anticoagulant, to the platelet reduction, or, indeed, to an abnormality in the capillaries themselves.

4. **Miscellaneous abnormalities other than those above** may be encountered under certain circumstances. For example, it is not unusual to find an increased prothrombin time shortly before death in animals dying from radiation injury, although

the prothrombin level never decreases enough to be cited as the cause of the bleeding.

The hemorrhagic syndrome by itself may cause death as a result of massive hemorrhage into a vital tissue or organ such as the brain. In addition the ulceration of the gastro-intestinal tract with erosion of blood vessels is a major source of blood loss as well as a site of bacterial invasion.

With this brief review of the clinical problem and the expected laboratory abnormalities we might ask ourselves the question—what can we as medical technologists do that would be of assistance following an atomic disaster?

Since hemorrhage is a relatively late manifestation of radiation sickness, other hematologic tests assume much greater importance during the first few hours to days after exposure. The simplest procedures are the only ones that can be employed under emergency conditions. It is very unlikely that the bleeding and clotting time, platelet determinations, protamine titrations, and the like will be possible except under the most favorable conditions. The fact that hemorrhagic manifestations of radiation injury appear relatively late and perhaps many of the victims will already have been hospitalized, will facilitate the determination of the definitive clotting abnormality and thus make specific therapy possible. The difficulty is, however, that little in the way of specific therapy exists at the moment except in such abnormalities as prothrombin deficiency or the presence of a circulating heparin-like anticoagulant. In the former, vitamin K can be administered and in the latter toluidine blue may be life saving. For abnormalities associated with platelet deficiency, only whole blood is available, but the transfused platelets under these circumstances are of only temporary help, if any. Perhaps if large quantities of viable platelets, such as Dr. Diamond's group prepares, can be given, the outcome may be different

In our laboratory the daily transfusion of whole blood to irradiated dogs has not raised the platelet or leucocyte count, prevented or controlled hemorrhage, or extended life beyond that of control animals. This is not to say blood should not be given, but thus far, we have no evidence that blood alone is of any value in treating irradiation sickness.

In the event it is impracticable to do laboratory tests to determine the underlying clotting abnormality producing hemorrhage, then a "shotgun" approach may be necessary in which all substances known to be effective for specific abnormalities can be given. If this becomes necessary, we must be sure that our combined therapy is not incompatible and that it will do no harm.

THE ROLE OF THE MEDICAL TECHNOLOGIST IN AN ATOMIC DISASTER

BACTERIOLOGICAL PROBLEMS

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The first problem facing the bacteriologist in an atomic disaster will be the public health problem of protection of water and food supplies for the surviving population. Among the casualties the bacteriologic work will at first be restricted but after the acute emergency is past there will be a need for bacteriological studies of wounds and of persons with infectious diseases and radiation sickness. The bacteriologist will also be in the forefront in watching for the possibility of a biological attack combined with the atomic attack.

Following an aerial or ground bombing, damage will result in a sharp drop in water pressure. What pressure remains or can be restored after emergency repairs will be so desperately needed for fire fighting that back siphonage of sewerage or use of unfiltered water will be disregarded temporarily. Water that can be used to fight fire will not necessarily be fit for drinking or even washing. In the Chicago stock yards fire of the mid-thirties, there was a severe outbreak of amoebiasis and some cases of typhoid among the firemen who drank from water used for fire fighting. There was no break in the water lines then, but because pressure had dropped excessively there was back siphonage of sewage and in addition the sewerage line had to be tapped.

All drinking water should be treated with emergency chlorination kits or boiled, until mains are mended or water rerouted. At this time the public health laboratories will be responsible for very frequent checks at many points throughout the city water system, necessitating increased work for those experienced in bacteriology and need for inexperienced persons who can be trained in collecting and sampling technics. During the time that water lines are being restored, some supply of water will have to be brought into the damaged area by truck from outlying regions. Tank trucks of many kinds can be used for this if they are adequately cleaned and checked both chemically and bacteriologically. Also many local wells such as those in some hotels or for air-conditioning systems or auto washing may be rapidly made available, primarily for fire fighting, but also for drnking and sanitary purposes if the water is chemically treated or boiled, until it has been cultured by the bacteriologists, and its safety assured in spite of unusual drain that would be made on these wells.

* Author wishes to acknowledge the assistance of Dr. Leon O. Jacobson in the preparation of this paper.

The bacteriologist, in making water analyses, should be watching not only the usual indicators of contamination, but should note with care any change in the normal flora as a possible indication of sabotage with chemical or biological warfare agents.

Also in the realm of the public health bacteriologist will be the guarding of milk and food supplies. Damage to pasteurization plants or interruption of their power or water supplies is a great danger. Much food handling for some time after an atomic disaster will have to be done in mass feeding centers. Here careful preparation and constant inspection will be necessary safe guards, but even so, the bacteriologist must be prepared to examine for enteric diseases and any other mass illnesses traceable to a feeding center whether the contamination might be due to carelessness or to sabotage.

In dealing with immediate casualties of an atomic bomb disaster, little or no bacteriologic work will be done during the first aid period. The usual incidence of infection of any piercing or crushing wound or of a burn could be expected, but in view of the number to be treated and with modern surgical methods of debridement and therapeutic measures, bacteriologic studies would rarely be used.

After the first emergency and as post-traumatic infections develop some cultural wound study will be necessary, especially as a guide to antibiotic therapy. No doubt "shot gun" antibiotic treatment will have to be administered in most cases at first, but later resistance to the antibiotic used will develop in some strains or non-sensitive organisms may become predominant. Most of us are familiar already with the great number of insensitive strains of staph aureus in wounds and the more and more common appearance of the highly antibiotic resistant pseudomonas and proteus species that replace the usual infective flora in treated patients.

It will not be part of the bacteriologist's work during the time of an atomic disaster to develop new antibiotics against these resistant organisms, but it is one of the great number of problems that must be faced in preparation for that time. Antibiotics against the low grade but persistant infectious agents such as the pseudomonas and proteus species and the yeasts are a problem for continuous study. Development, preparation and stockpiling of effective vaccines against possible epidemic or biological warfare agents is another phase of the bacterologist's work before the time of attack. Effective vaccine is already available against smallpox and toxoids against botulinus A and B toxins. Partially effective vaccines which might reduce the incidence or duration or severity of disease are available for typhoid, tularemia, plague, typhus, Q fever, yellow fever, cholera, and possibly psittacosis and brucellosis. It is not likely that im-

munization of the entire population against all agents would be sound, but a rapid immunization in time of need from an adequate stockpile of materials already on hand could be of great benefit in controlling infectious diseases whether due to direct enemy action or to indirect action as a result of bomb damage to sanitary facilities. Co-operation with blood banks, central supply of hospitals, and control work in biological supply companies will require the time of many bacteriologists both before and following an atomic attack for checking the sterility of intravenous solutions, of plasma, and of medicines.

The care of persons exposed to high dosages of radiation will bring the bacteriologist not new and unfamiliar problems but a tremendous accentuation of familiar ones. The difference will lie not in the bacteria, for radiation effects in them have not produced changes in the kind of mutations from those known naturally but have increased only the number of mutants. The real difference will lie in the host—in the irradiated human being.

In radiation the blood cell forming organs and the reticuloendothelial system, the two principal defenses of the body against invading bacteria, are severely damaged. The mucosa of the intestine also is susceptible to radiation injury and the skin in casualties will probably no longer be intact because of burns or wounds. Hence both the internal and external surfaces of the body which normally have heavy bacterial populations will be broken or damaged to give the bacteria ready access to the tissues. And in the tissue, because the phagocytic leukocytes and the antibody producing cells are not functioning, the bacteria can multiply without hindrance.

Experimental studies with irradiated animals have shown that infection plays a very important part in the terminal stage of fatal radiation sickness. Miller and Hammond reported positive blood and spleen cultures in 5% of sacrificed mice on the second post-irradiation day when no deaths had yet occurred among 585 mice. The incidence of positive cultures rose rapidly to as high as 85% among the sacrificed mice on the ninth post-irradiation day when the death rate was also highest. In another group of over a thousand mice which received a lower, but still above the LD50 (the dose that kills 50% of the mice), dose of radiation the percentage of positive cultures went up to 54 on the tenth day when deaths were highest. The cultures showed only organisms which were normal inhabitants of the large intestines of the mice, with paracolons, coliforms and proteus predominating. 91% of the cultures showed only one organism and the remainder only two, suggesting that the bacteria were actively multiplying in the tissues and blood stream. Attempts were made to control these overwhelming infections with antibiotics, to try to keep the animals alive until regeneration of the hemato-

poietic system had taken place and the cellular and humoral defenses against bacterial invasion were again active. Streptomycin and polymixin were effective for these organisms but centage of deaths. Oral administration of aureomycin and chloromycetin were tried with results slightly less valuable. In some groups of animals, proteus and especially pseudomonas species became the most common causes of fatal infections. Only streptomycin and polymyxin were effective for these organisms but the toxicity of polymyxin and the rapid development of resistance to streptomycin made them of little use in protecting the mice. From their work on mice, Miller and Hammond conclude that antimicrobial therapy, while not a cure for radiation injury, can be highly effective in preventing death from infection after exposure to moderate doses of radiation. Because of the necessity of continued antibiotic therapy in treatment of radiation casualties, the medical bacteriologist will have to be prepared to make rapid accurate appraisals of antibiotic sensitivity of infecting organisms from wounds and from the blood stream. He should be able to cut identification methods to a minimum without sacrifice of accuracy or speed to give preference to sensitivity testing.

Also the hospital laboratory is a place where the first recognition of a biological attack combined with the atomic attack may be made. Although many bacteriologists will be specialists in this field with monitoring of air, food and water and study of artifically introduced pathogenic agents as their primary interest, every one who is handling infectious material has a chance to find an unusual organism or to spot any change in the normal distribution of bacteria in the human population. The possibility of agents of biological warfare being spread at the same time as an atomic attack should be borne in mind by the bacteriology technician and any unusual findings reported at once to the public health authorities. At all times, in such a disaster, the bacteriologist will be working not only for the individual patients but for the protection of the community of which he himself is a part.

BIBLIOGRAPHY

The Effects of Atomic Weapons, Department of Defense and Atomic Energy Commission, Sept. 1950, U. S. Government Printing Office, Washington, D.C.

U. S. Civil Defense, Health Services and Special Weapons Defense, 1950, U. S. Government Printing Office, Washington, D.C.

Miller, C. Phillip and Hammond, Carolyn W., The Role of Infection in Radiation Injury, Trans. Assoc. Am. Phys., LXIII: 155-160, 1950.

Miller, C. Phillip and Hammond, Carolyn W., The Effect of Terramycin on Post-irradiation Infection in Mice, Annals N. Y. Acad. Sc., 53: 303-308, 1950.

PRESENT STATE OF KNOWLEDGE ON PROTEINS AND FORMED ELEMENTS OF BLOOD: THEIR PRESERVATION AND POTENTIAL USE

a) Leukocyte Studies

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At present the normal span of life of the leukocyte is a controversial subject. However, we do know that in vivo the white cell has a short life—probably only a matter of hours. Therefore, in order to study white cell viability for any length of time it was necessary to find suitable methods for collecting, separating and preserving these cells in vitro.

Until just a few years ago white cells collected under the conditions generally used were not in their natural viable state, since leukocytes are damaged when they are subjected to wetting surfaces such as those of rubber or glass. It was then realized, thanks to the studies of Drs. Jacques and Brinkhous, that all surfaces coming in contact with white cells and platelets should be similar to blood vessels, i.e., they should have a smooth mirror-like, non-wetting surface to prevent the cells from sticking to the surface and being destroyed. Consequently, flexible, clear polyvinyl chloride acetate copolymer equipment, arquaded metal and silicone-coated glassware are used exclusively for the collection, separation and preservation of white cells and platelets.

The anti-coagulants, citrate and ACD, which are being used routinely in our blood banks, have been found toxic to leukocytes, severely affecting them morphologically and physiologically. This led to our present method of collecting blood through an ion-exchange resin column which removes the calcium ions.

Another pre-requisite found necessary for white cell viability is a temperature between 5 degrees C. and 0 degrees C. during separation and preservation periods to prevent agglutination, to help maintain cell structure and morphology, and better to preserve their physiological functions.

At the present time we are obtaining our white cells by means of dextran sedimentation of red cells, running the supernatant plasma through a 2-stage falling film centrifuge and washing the cells free from their native environment as quickly as possible before enzymatic activity destroys them. The cells are eluted and stored in a phosphate buffer physiological salt solution to which a colloid, currently gelatin, has been added. Cells stored in this type of media have been found viable for periods three to four times longer than previously reported.

Our methods of studying preserved white cells and estimating percentage survival data include macroscopic examination for absence or presence of fibrin material, pH determinations, routine white counts, and eosin staining. In addition our tests for viability in terms of motility include examination for Brownian motility under darkfield, and for ameboid motility under a phase microscope at 37 degrees C. The only functional test we are performing is starch phagocytosis. Occasional respiration studies on our preserved white cells have shown oxygen consumption. Tissue culture implants have shown normal migration under phase microscopy.

It is quite evident that we are living in an atomic age with the possibility of experiencing the catastrophe of atomc warfare. Fact-finding studies at Hiroshima and Nagasaki give ample evidence that leukopenia of marked degree occurred in those individuals exposed to large doses of irradiation within the ten to thirty day period after exposure. It is, therefore, imperative that one of the goals of medical defense research should be the collection, separation and preservation of viable leukocytes in a state suitable for therapeutic use in combating acute radiation effects.

b) Platelet Studies

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The study of platelet morphology and physiology has been aided by several recent developments. These include two modifications of the Blood Bank routine blood collection, followed by a very rapid separation of the platelets from the other elements of the blood.

In the first place, good platelet specimens are obtained only when all the surfaces which the platelets contact are non-wettable, whether tubing, needles, or glassware.

Secondly, while citrate and ACD solutions are adequate anticoagulants for blood used in Blood Banks, these chemicals injure the platelets. For this reason, platelet specimens are collected from blood which has been decalcified by ion-exchange resins, as developed by Gibson and Buckley.

The rapid separation of the white cells and platelets begins with an accelerated sedimentation of the red blood cells. The long needle-shaped molecules of Dextran were found by Minor and Burdett to induce rapid rouleauxing of the red cells, without injuring or sedimenting the white cells and platelets.

After the red cells are removed from the sedimented blood, the platelets and white cells are separated from the plasma by a special centrifuge. This separation is based on the fact that

white cells have a higher specific gravity than platelets, and so may be centrifuged out with a lower force than that required to precipitate the platelets.

The actual separation occurs inside two cylindrical bowls which are in contact, but spin at different rates. The plasma, containing platelets and white blood cells, enters the first bowl which is spinning with a force 120 times gravity. This force will throw the white cells against the wall and hold them there uninjured, while the plasma and platelets flow down to the second bowl. The velocity of the lower bowl is 400 times gravity, which is sufficient to deposit the platelets along the wall. After the plasma is drawn off, the white cells and platelets may be washed off the walls of their respective bowls, and stored separately in suitable media.

When ion-exchange columns are used, 40-50% of the platelets are filtered off by the resin beads. These platelets may be eluted by passing a suitable media through the column.

There is at present no standard measure for determining the viability of platelets. Consequently, our studies chart the morphological changes which occur in the stored platelets. The physiological activity of the various forms is measured by their ability to cause clotting.

The morphology of platelets varies with the age of the specimen, and with the medium used for storage. The observations reported in this paper have all been made with a phase microscope. Fresh specimens stored in saline may have one or more flexible spicules protruding from a compact mass of blue granules. These spicules may reach a length several times the diameter of the platelet, and occasionally show branches. Slightly older specimens may have a number of short curved spicules, and so take on the appearance of a burr.

When platelets are preserved in a buffered salt solution, the spicules disappear almost immediately. Instead, the central core of granules becomes surrounded by a clear, flat, undulating cytoplasmic membrane, which may increase the diameter of the platelet fourfold.

After prolonged storage, both of these early forms disappear, giving rise to forms which no longer vary with the media. The platelets become spherical or ballooned. The granules which have previously remained in a compact blue mass at the center of the platelet, now separate from each other and bounce around rapidly within the clear cytoplasmic membrane. As the membrane continues to swell, the granules become further separated within the sphere. Consequently the platelet becomes very pale, and tends to resemble the ghost of a red cell.

Comparison of the clotting abilities of the various morphological forms described above may soon show which type of

platelets show the greatest physiological activity. It may then be possible to find the most suitable preserving media for stockpiling platelets.

At present, platelet studies are carried out largely in vitro. However incipient transfusions have shown that in vivo experiments may soon be possible.

c) The Clotting Components

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This paper will concern itself with the isolation and preservation of the elements of the clotting mechanism. The advent of the atomic bomb has enhanced the value of such studies both from the point of view of the light they throw on the workings of the clotting mechanism and also the provision of stockpiles of the clotting components for use in civil defense.

An outline of the coagulation mechanism leaving out elements whose function is not well known is as follows:

Ca, thromboplastin, Ac Globulin

1st Stage PROTHROMBIN ——— THROMBIN

Serum Prothrombin Conversion Accelerator (SPCA) is evolved in this stage. It functions to speed up the reaction.

Thrombin

2nd Stage FIBRINOGEN ——— FIBRIN

Of these components fibrinogen, thrombin and fibrin are prepared commercially. They are used as hemostatic agents in surgery. Of the remaining components, prothrombin holds the key position because of its possible use clinically.

Prothrombin can be absorbed quantitatively on barium sulfate and can be eluted with 0.15 M trisodium citrate. This fraction contains about one percent of the plasma proteins but by washing the barium sulfate paste with saline or sodium oxalate solution some of the extraneous protein may be removed and an activity of 720 units per mgm. of protein has been attained, on the basis of 200 units per ml. in normal plasma. Efforts are being made to increase the concentration and to find means of sterilizing and stabilizing the resulting solution.

The great delicacy of the clotting mechanism is the chief obstacle in solving the problem of the isolation and stabilization of its components. Accelerator globulin, a labile factor, will disappear in 72 hours from plasma stored in a refrigerator and much faster if left at room temperature. Prothrombin, itself, will deteriorate in stored blood in about three months. When

plasma is irradiated with ultraviolet light or by cathode rays the prothrombin is inactivated before any other change is detectable by electrophoresis.

This liability of the clotting mechanism is not without its benefits, for, if we can handle blood or plasma without damaging the coagulation mechanism we know that we have handled it gently. Indeed the modified One-Stage prothrombin analysis (see Dr. Benjamin Alexander's discussion*) is an excellent assay of the condition of plasma.

If plasma fractionation is to provide a maximum number of useful components, the separation must be carried out on fresh blood. This fact is so fundamental that Dr. Edwin Cohn's group at Harvard University is developing methods of processing blood directly as it leaves the donor.

d) Studies of Red Blood Cell Preservation

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Threat of another world conflict has stimulated civil defense authorities in recent months to study new methods of blood preservation in relation to many of its important elements. Dr. Charles Emerson of the Massachusetts Memorial Hospitals in Boston has been working on a new method of blood collection and experimenting with methods of red cell preservation in regard to this problem.

A new type of donor set is being used which utilizes a resin column and ion-exchange principle instead of the standard ACD anticoagulant. The set is entirely plastic and can be autoclaved. The resin column has been previously rinsed with saline and it is the sodium from the saline that replaces whole blood cations, principally those of calcium. The needle used is designed so that there is no place for air entrapment. The surface to the steel in the needle is coated with a non-wetting substance like plastic which withstands autoclaving. Resin collected blood has advantages over citrated blood as it is unadulterated, there is no visible destruction of white blood cells, and the plasma can be better used for fractions.

Several methods of separating the red cells from the remaining elements in the plastic bag have been tried. The first and by far the best method is by spinning the bags down. This is accomplished by placing the bag in a lucite jar and surrounding it with water. Spinning is done in a regular blood bank centrifuge for 20 to 30 minutes at 200 to 250 g. The red cells settle out well leaving a good buffy coat of white cells on top. The plasma and

* To be published (AJMT).

white cells are removed simply by forcing more water into the lucite jar and squeezing them off. Other separating methods depend on rouleauxing of red cells. Fibrinogen and dextran were used with success, but the disadvantages in the rouleauxing agents themselves make them inadvisable for donor use.

It was found that resin red cells cannot be preserved as long as those taken in ACD so it was necessary to experiment with diluents or preservatives. Various substances were used, such as dextrose-saline, sucrose, carbon dioxide, ACD itself, and certain trace metals such as Mg, Zn, and Co which are removed in the resin column. ACD proved to be the best preservative. The reason is not known but probably depends on the characteristics of the citrate ion. It is also necessary in preserving red cells to put back a little plasma along with the ACD or the red cells will be rapidly destroyed. This can be accomplished either by removing only $\frac{4}{5}$ of the original plasma or by adding $\frac{1}{5}$ of it with the ACD. At the proper temperature of 4 degrees C., red blood cells thus preserved can be stored for three to four weeks with 70% of the cells in good health at the end of the time.

The actual study of the red cells collected and stored in various ways has been made by two procedures. The first is the in vitro test by the use of the erythrocyte osmotic fragility, and the second, the *in vivo* test by the survival of donor cells in a recipient.

The osmotic fragility test is an excellent indication of blood deterioration. High fragility indicates poor survival. The test is a quantitative one employing straight saline dilutions and a 1:50 dilution of blood. Hemolysis occurs instantly after centrifuging and can be read. The pH of the blood to be tested is very important. Normally blood is alkaline with a pH of about 7.3. Stored blood tends to become acid. It was found that acid bloods tend to have an osmotic fragility curve which shifts to the left of the normal curve. If stored blood or acid blood have their pH returned to normal, the test is valid. Blood can be alkalinized by adding normal AB plasma, by CO_2, and by the original plasma. A formula has been derived now so that blood no longer has to be equilibrated as long as the pH is known.

The proof of the pudding is in the survival of red cells in normal compatible recipients. The things we are interested in are what proportion of the cells live at all and how the remaining cells do. The proportion of cells that live can be determined first by the blood volume. The test is done using Evans Blue on the day following transfusion. The volume of donor blood is known and can be used to determine the number of donor cells surviving.

An Ashby count is a centrifuge technique used to determine the number of donor cells remaining in the patient at various

intervals, post transfusion. Donors are chosen with compatible blood but with one element different so that antigens can be used in the test to agglutinate the patient's cells and leave the donor's cells free to be counted. (Group O blood given to a Group A recipient and anti-A serum used to agglutinate the recipient's Group A cells.) A 1:200 dilution of the blood is made and a red count done on it, an aliquot is added to dried grouping serum, spun, and a count of all the non-agglutinated cells is made. From the red count and the test count, the percentage of donor cells remaining in a patient can be calculated.

The preservation studies are long and complicated. Blood is not interesting until it is stored for three weeks and then not until it is in the recipient. Three or four months are then needed to complete the study in the recipient. However, a good starting point has been made for the study of red cell preservation. It may be found that citrate is the best preservative. It is feasible that red blood cells can be preserved longer than they are now. It is even possible, by analogy, to imagine that red cells can be preserved longer by artificial means than they can by the body itself where they are subject to a temperature of 37.5° C. and all the body enzyme systems.

SUMMARY AND DISCUSSION

By Leon O. Jacobson, M.D., Associate Professor of Medicine and Associate Dean of Biological Science Division, University of Chicago, Albert Merritt Billings Hospital and member of the Division of Biological and Medical Research, Argonne National Laboratory, Chicago, Illinois, and James L. Tullis, M.D., Harvard University, Boston, Massachusetts.

Dr. Jacobson:

I'm going to make my discussion very brief, again, because, most of the things I wanted to say have been amply discussed. Actually the picture that has been drawn for you is the picture of what happens in the human organism after exposure to radiation which is the thing we are concentrating on this morning, from the technologist's point of view and the physician's point of view. The latter part of the discussion this morning was on some of the things which are being investigated to take care of this situation in the event it occurs. I assume Dr. Tullis is going to discuss that aspect of the program. I want to take this opportunity to tell you in a very few sentences, one other aspect that we are trying to cover in treatment of radiation injury. Some of you may remember last year at your convention at Houston, that we had an exhibit showing some experimental work on mice. This work has gone on now in the last year and we have been trying to see if we can influence the recovery from radiation. At this time, we are able to change the picture from (in animals) death to survival. We can give animals twice the lethal dose of radiation and by implanting into the peritoneal cavity, 10 mg. of spleen, the animals will survive. Blood formation returns very quickly. The gastrointestinal tract repairs itself very rapidly. I bring this up only to indicate to you, that in

addition to work that Dr. Tullis is going to report, there is some progress in the field which makes the very serious problem of atomic warfare perhaps, just a little easier to think about. It is not impossible that in the next few years, if it isn't too late, we will have medicinals which are actively and specifically available to treat and reverse the radiation injury which were discussed. And in addition, the blood with all its constituents and which are so important to radiation injury, may be available in such a form that they would be useful. At the present time this is pointed out, only the red cell is useful. The problem of the technologist, I am sure, it's impossible to really think the problem out in advance and know just what will one's role be. How many blood counts are you going to do? How many differentials? How many platelet counts? Well, I rather think that, except as was pointed out, the patients who are brought out into hospitals in the periphery of a bombed area are the only ones actually that you are going to have a chance to work on and there the numbers are so great that the amount of work that can be done will be extremely limited. And so that the problem as I see it now is to be aware of what radiation does and to push the research in blood and blood substitutes and push the research which has to do with the therapy of radiation injury itself. Thank you very much.

Dr. Tullis:

In accordance with Dr. Jacobson, I wish to emphasize that the technical speakers have covered the subject and delineated the various technical problems so well there is little I wish to add. With regard to the final four speakers from our group at Harvard, I wish to summarize just two points: First of all, our work thus far has been predicated on the thesis that all components of blood, which are separated from their native environment, are more stable than they are when they are in the complex heterogeneous system known as blood. All of the components that we have separated thus far had shown greater stability and greater ease of preservation when free from the various enzymes which act upon them. The second point merely is to emphasize that the work thus far is purely experimental and has not reached the stage where we would wish to state that we are beginning in vitro experimentation. Although the platelet preservation has gone far enough that a few platelet transfusions have been given thus far and with encouraging results. The white cells thus far are still in the in vitro phase. Sufficient experimental evidence exist to indicate strongly that there will be difficulty in transfusing white blood cells if that stage is reached. However, we have felt this should in no way detour our efforts to try and prolong their life span and some progress in that field has been made. Thank you.

ANEMIA IN THERMAL AND RADIATION INJURY*

By MARY A. MALONEY, A.B.

In the event of an atomic bomb emergency, the injuries sustained would not only be from irradiation but also from thermal burns and mechanical trauma. There are relatively little experimental data available on combined radiation and thermal injury. However, there can be little doubt that the combination of injuries would have cumulative effects. It has been estimated that at Nagasaki seventy-five percent of all injuries were burns and that burn injuries accounted for fifty percent of all fatalities.

In thermal burns, the dysfunction of the red cell, at first, is hemolytic in nature. James et al.[1] state that in all serious burns, there is an increase in hemolytic index as judged by fecal urobilinogen studies. Ham et al.[2,3] demonstrated that the early increased hemolysis of the red blood cell is directly related to the heating of the blood at the time of burning as determined by in vitro and in vivo studies in dogs. The heating causes changes in the shape of the red cell towards spheroidicity and increases the osmotic fragility. The fragmented red cells and spherocytes, which are found, break down rapidly causing hemoglobinemia and, in the severe cases, hemoglobinuria. In normal subjects the plasma hemoglobin concentration must reach levels of about 135 mgms. per 100 cc. before hemoglobinuria develops. This will continue until the hemoglobin concentration of the plasma falls to a level of 30-50 mgms. per 100 cc. Although there is no evidence as to the level plasma hemoglobin has to reach before hemoglobinuria exists in burn patients, it is probably safe to assume that it has to approximate the level in normal people. The hemolytic process is not only important to the patient from the point of view of anemia, but also in regard to kidney function. Goodpastor et al.[4] studied the kidneys of burn patients who showed clinical evidence of kidney dysfunction. Grossly the kidneys with anatomic abnormalities had pale, swollen cortices with contrasting dark medullas. Histologically the tubules contained blood pigment casts which gave a positive "hemoglobin stain," although no specific identification was made. The combination of factors leading to kidney dysfunction are shock, with decrease in renal blood flow, acidosis, and methemoglobinemia.

The severity of the hemolytic phase is dependent upon the depth and extent of the burn. The early phase probably terminates at about 72 hours. However, in severe burn cases, a chronic anemia ensues which continues until healing is complete. The etiology of this anemia is obscure.

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*From The Army Medical Nutrition Laboratory, Chicago, Illinois.

Infection of the burned area is a common complication of deep burns. Saifi and Vaughan[6] demonstrated that in infection, the marrow is active but the predominant cells are normoblasts and primary erythroblasts which suggests a maturation arrest at this point. They felt that the anemia of infection was due to interference in the synthesis of hemoglobin. Wintrobe et al.[7] demonstrated that this interference was due to faulty absorption or iron. Even though adequate iron was given patients with anemia due to infection, it did not correct the anemia and the iron not used for hemoglobin metabolism was deposited in the liver and spleen. Wintrobe et al.[8] found that anemia of infection could be prevented in rats by giving oral cobalt chloride prior to infection. Robinson et al.[9] showed that in patients with suppurative infection, that oral administration of cobaltous chloride greatly enhanced the manufacture of hemoglobin. Wintrobe[10] stated that cobalt appears to counteract the inhibiting effect of inflammation in iron absorption. He feels that the anemia is not the consequence of alteration of iron metabolism, since it is not alleviated by large doses of iron.

In dressing changes and skin grafting there is blood loss which is a contributing factor to the anemia.

Emerson and Ebert[5] demonstrated that pooled plasma and type O blood given to patients with A, B or AB antigens, may cause a severe and prolonged hemolytic process. This, however, may be avoided by giving group specific blood and plasma, or adding A and B substances to pooled plasma.

Another factor which may be important to the etiology of the anemia of burns is bone marrow depression either primary or secondary. In severe burn cases, whole blood is administered either to correct the anemia or to maintain the circulating blood volume at an adequate level. Levenson et al.[11,12] demonstrated that in normal healthy males transfused to a polycythemic state, a decrease in erythropoiesis follows. This depression of marrow activity is directly proportional to the amount of red blood cells received above their normal level. For example, in a patient receiving red blood cells equivalent to 20% of their own circulating red cell mass, there is 50% suppression of marrow activity; at 40% there is a 100% suppression. This manifests itself at about three weeks post transfusion. Following this, there is a gradual return to normal. At the present time, at the Medical College of Virginia, the effect of the transfused red cells on the marrow activity of patients with serious injury is being studied. Even though the amount of red cells transfused brought their circulating red cell mass up to a level that is considered to be normal, a marrow suppression similar to that found in normal males made polycythemic may ensue.

In the healing process of burn patients, there is a great demand for protein and vitamins. It is possible that if this protein and vitamin need is not met, the anemia is aggravated.

In considering radiation injury, there are no conclusive data to indicate that the circulating red cell is seriously damaged. Lawrence et al.[13] state that the anemia following radiation is dependent upon injury to the erythropoietic tissues. Hence the anemia will not be detected until the circulating red cell mass in normal utilization is not replaced by production of red cells from the erythropoietic tissues. Bloom[14] demonstrated in mammals, the bone marrow activity of the erythropoietic system is affected before the myelocytopoietic system. In rabbits as early as ½ hour after irradiation, the erythroblasts in the marrow were reduced in number and the surviving ones were primarily late forms. At the end of 24 hours, the erythroblasts had dropped to a minimum. The severity of depression is directly dependent on the dosage of irradiation. With subsequent recovery of the marrow, the erythropoietic system demonstrates a preponderance of young forms.

As well as the erythropoietic marrow depression, there is also a myelocytopoietic depression. Hence the infection of the burned area would be greater. The greater the infection the more severe the anemia.

Another complication of radiation injury is bleeding and therefore, blood loss may be a contributing factor to the anemia.

In conclusion, it is evident that combined thermal and radiation injury would result in serious acute and chronic anemia. Increased red cell destruction, blood loss and marrow depression due to a number of factors would all contribute to this end. The proper care of the injured patient will necessitate cognizance and treatment of the anemia.

REFERENCES

1. James, G. W. III, Purnell, O. J., Evans, E. I.,—
The Anemia of Thermal Injury I. Studies of Pigment Excretion. Journal of Clinical Investigation, 30:181-190. 1951.

2. Shen, S. C., Ham, T. H.,—
Studies in the Destruction of Red Blood Cells: III Mechanism and Complication of Hemoglobinuria in Patients with Thermal Burns; Spherocytosis and Increased Osmotic Fragility of Red Blood Cells. New England Journal of Medicine 229: 701-713, 1943.

3. Ham T. H., Shen S. C., Fleming, E. M., Castle, W. B.,—
Studies in the Destruction of Red Blood Cells IV. Thermal Injury: Action of Heat in Causing Spheroidicity, Osmotic and Mechanical Fragilities and Hemolysis of Erythrocytes; Observations on the Mechanism of Destruction of Such Erythrocytes in Dogs and in a Patient with a Fatal Thermal Burn: Blood III, 373-403, 1948.

4. Goodpastor, W. E., Levenson, S. M., Tagnon, H. J., Lund, C. C., Taylor, F. H. L.,—
A Clinical and Pathologic Study of the Kidney in Patients with Thermal Burns. Surg. Gyn & Obst., 82: 652-670, 1946.

5. Ebert, R. V., & Emerson, C. P. Jr.,—
A Clinical Study of Transfusion Reactions; The Hemolytic Effect of Group O Blood and Pooled Plasma Containing Incompatible Isoagglutinins. Journal of Clinical Investigation 25: 627-638, 1946.

6. Saifi, M. F. & Vaughan, J. M.,—
Anaemia Associated with Infection. Journal Path. & Bact. 56: 189-197, April 1944.

7. Greenberg, C. R., Ashenbrucker, H., Lauriston, M. & Wintrobe, M.M.,—
The Anemia of Infection. IV The Lack of Relationship Between the Diversion of Iron from the Plasma and the Origin of the Anemia. Journal of Clinical Investigation: 26-114, 1947.

8. Wintrobe, M. M., Grinstein, M., Dubash, J. J., Humphreys, S. R., Ashenbrucker, H., & Worth, W.,—
The Anemia of Infection VI. The Influence of Cobalt on the Anemia Associated with Inflammation. Blood II 323-331, 1947.

9. Robinson, J. C., James, G. W. III & Kark, R. M.,—
The Effect of Oral Therapy with Cobaltous Chloride on the Blood of Patients Suffering with Chronic Suppurative Infection. New England Journal of Medicine 240: 749-753, 1949.

10. Gubler, C. J., Cartwright, G. E., Wintrobe, M. M.,—
Influence of Inflammation, Cobalt Administration, Diet & Pyridoxine Deficiency in Iron Absorption. Abstract American Journal of Medicine: 8, 537, 1950.

11. Levenson, S. M., Birkhill, F. R., Maloney, M. A., & Bell, J. A.,—
Metabolic Fate of Infused Erythrocytes. Ann. Surg. 130, 723-746, October 1949.

12. Birkhill, F. R., Maloney, M. A., Levenson, S. M.,—
Effect of Transfusion Polycythemia Upon Bone Marrow Activity and Erythrocyte Survival in Man.—Blood. (In press)

13. Lawrence, J. S., Dowdy, A. H., & Valentine, W. N.,—
Effect of Radiation on Hemopoiesis. Radiology, 51: 400-413, 1948.

14. Bloom, M. A. & Bloom, W.,—
The Radiosensitivity of Erythroblasts. Journal Lab. Clinical Medicine, 32: 654-659, 1947.

ATOMIC BOMB RADIATION CASUALTIES: THEIR DIAGNOSIS, PROGNOSIS AND TREATMENT[1,2,3]

By DUDLEY P. JACKSON, M.D.[4]

Since the release of the news of the atomic bombing of Hiroshima and Nagasaki, there has been an ever increasing interest in the biologic effects of radiation. Also, with the current emphasis on civil defense, it has become necessary for the medical profession and its allied specialties to become familiar with the consequences of possible atomic warfare. An effort will be made here to outline briefly some of the manifestations of the one new type of injury introduced to military medicine with the advent of the atomic bomb, namely, radiation injury.

First, however, it should be pointed out that many, in fact the majority, of the casualties that were seen in Hiroshima and Nagasaki sustained injuries that are quite familiar to the medical profession, namely, traumatic injuries and thermal burns. Dr. G. V. LeRoy, a member of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan, reported[1] that of the total number of Japanese casualties, 70 per cent sustained traumatic wounds, 65-85 per cent sustained burns, and somewhat more than 30 per cent sustained radiation injury. From these figures, it is apparent that many of the casualties sustained more than one type of injury. Radiation injury alone was seen in approximately 1/7 of the total number of Japanese casualties.[1] Although percentagewise radiation injury was the lesser problem, 10-20 per cent of one hundred thousand casualties still presents an impressive challenge.

In general, the injuries produced by ionizing radiation may be divided into two major categories:

1. The acute injuries, and
2. The chronic injuries.

It is the acute type of injury that will be discussed. The acute types of injury may be separated into four subdivisions, namely, the acute injury produced by:

1. Sectional surface exposure to poorly penetrating radiation,
2. Total surface exposure to poorly penetrating radiation,
3. Sectional body exposure to penetrating radiation, and
4. Total body exposure to penetrating radiation.

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1. Presented at the Nineteenth Annual Convention of the American Society of Medical Technologists in Swampscott, Massachusetts, on 26 June, 1951.
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3. The opinions or assertions contained herein are the private ones of the author and are not to be construed as official or reflecting the views of the Department of the Navy or the naval service at large.
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This presentation will be confined to a discussion of this last type of injury, since it is the single, intense, total body exposure to penetrating ionizing radiation that produces the so-called "syndrome of acute radiation injury."

For practical purposes, it would seem desirable to have some method of segregating atomic bomb radiation casualties with respect to degree of injury. As a guide to the expected sequence of events, the prognosis and the treatment of such casualties; the segregation of an exposed population on the basis of symptomatology as proposed by Cronkite[2] seems a rational approach. By this system, the casualties would be divided into the following three groups:

1. Group I—survival improbable (supra-lethal range),
2. Group II—survival possible (lethal range), and
3. Group III—survival probable (sub-lethal range).

According to Cronkite,[2] the general clinical pattern that can be expected in these three groups will be:

1. In the Group I (survival improbable) casualties:
   a. Vomiting will occur immediately or within a few hours after the bombing,
   b. The illness will be of rapid tempo with no latent period,
   c. Rapidly progressive anorexia, nausea and vomiting, diarrhea, dehydration, fever, prostration, and shock will follow an initial toxemia, and
   d. Death will occur within a few days.
2. In the Group II (survival possible) casualties:
   a. Vomiting will occur within a few hours after the bombing, but the vomiting will subside within 24 hours,
   b. Following this initial vomiting, there will be a relatively asymptomatic latent period of from one to three weeks,
   c. This relatively asymptomatic latent period will be terminated by a return of symptoms which will include—in many cases—epilation, purpura, sore throats and other oral and cutaneous infected lesions, infection and breakdown of wounds or burns that otherwise had been healing well, and bloody diarrhea; and
   d. The uncomplicated, untreated mortality of this group probably would be in the neighborhood of 50 per cent.
3. In the Group III (survival probable) casualties:
   a. There will be no vomiting on the day of the bombing,
   b. The late symptoms, if any, will be milder but similar to those of Group II,
   c. Without late symptoms, it will be possible to detect these casualties only through the use of serial leukocyte studies, personnel radiation dosimeters, and/or distance of the individual from the explosion of the bomb, and

d. Mortality of casualties in this group uncomplicated by other types of injury will be low.

This type of casualty segregation has the advantage of being based on clinical observation and judgment without the necessity of detailed laboratory procedures and special equipment. It is not implied that serial blood studies, radiation dosimeter readings, calculations as to distance of an exposed individual from the site of explosion, and other related findings would be without value. However, in the chaotic conditions likely to exist following an atomic bombing of a major city, most of those latter observations would be impracticable.

Furthermore, it is realized that, with the above classification of casualties, a great deal of emphasis has been placed on the presence or absence of vomiting. Certainly with the panic that is likely to follow such a catastrophe as an atomic bombing, one might readily observe vomiting from psychological causes. Thus certain casualties, in whom vomiting was caused by these psychological factors, erroneously might be placed in Group II, but subsequent clinical observation would indicate that they actually belonged in Group III. Likewise, one well might see some casualties that have no vomiting on the day of bombing, and though initially classified as Group III, they would have to be reclassified into Group II due to the subsequent tempo and severity of their illness. Thus such a classification, though not rigid nor perfect, is presented as a working guide that might prove of value under the extremely difficult conditions to be expected after such a bombing, and when extensive laboratory work and follow-up of all patients probably would not be possible.

Where possible, serial blood studies would assist in classifying radiation casualties. Time will not be taken here to dwell on the details of the hematologic response to radiation injury, but interested readers are referred to the recent reports of Dunlap,[3] Henshaw,[4] Lawrence, *et al.*,[5] Jacobsen, *et al.*,[6] LeRoy,[7] and Cronkite[8,9] to mention but a few. In general, the absolute lymphocyte level 24 hours after exposure is considered a good index of the degree of exposure in the sublethal range. Some findings that would be considered favorable prognostic signs are: granulocytes remaining above 1500 per cubic millimeter, return of platelets to and/or failure of platelets to fall beneath 75,000 per cubic millimeter, and the development of a reticulocytosis. Some findings that would be considered unfavorable prognostic signs are: the development of a severe granulocytopenia with granulocyte levels beneath 500 per cubic millimeter, the development of a profound thrombocytopenia, no reticulocytes, and the development of prolonged whole blood clotting time in the presence of purpura.

Turning now to considerations of therapy of these three groups of casualties, it would seem that standard therapeutic procedures directed toward prolonging life until regeneration of radiosensitive tissues begins would be the logical approach.

In the Group I (survival improbable) casualties, therapy would be directed primarily toward maintaining fluid and electrolyte balance coupled with measures to protect the severely damaged bowel. If life of these casualties is prolonged to a period of from one to three weeks, they then would fall into the Group II category as regards therapy.

It is in the Group II (survival possible) category that the major therapeutic potentialities and problems are likely to occur. Cronkite[2,9] lists the four recognized potentially lethal factors in this group as:

1. Infection
2. Hemorrhage
3. Anemia, and
4. Disturbance of fluid and electrolyte equilibrium.

In this connection, it is of interest to note that Allen, *et al.*[10] make the following statement. "These latent sequelae constitute the postirradiation syndrome, which is characterized primarily by hemorrhage, infection, anemia, and malnutrition."

The disturbances of fluid and electrolyte equilibrium are produced by the anorexia, vomiting, diarrhea, and fever.[2,9,10] Since clinicians are familiar with fluid and electrolyte imbalances from these causes, there is no need to dwell here on the established therapeutic procedures used in their treatment.

The anemia seen in this syndrome probably is due to a combination of the following factors: cessation of production of red blood cells, hemorrhage, increased red blood cell destruction, and infection. One could not predict with certainty which of these would be of paramount importance in any particular casualty. However, the treatment of the anemia seen in this syndrome is that of replacement.[2,9,10] Again, one need not dwell on the conventional therapeutic approach of replacement therapy in anemia.

Recently a great deal of work has been reported on the pathogenesis of the hemorrhage seen in the syndrome of acute radiation injury. Prior to 1948, most workers considered the profound thrombocytopenia as the major cause of this hemorrhage. In 1948, Allen, *et al*[11] introduced the interesting concept of the release of heparin or heparin-like substances into the blood as the primary cause of the hemorrhage. However, recent work in this laboratory[12] as well as in other laboratories[13,14] has failed to confirm this concept. In the opinion of the author, the hemorrhagic syndrome of acute radiation injury can be explained on the basis of the profound pancytopenia, severe infections, increased capillary fragility with possibly other vascular factors, and the

changes attributable to these conditions.[12,15] If this hypothesis be correct, the treatment of the hemorrhage seen in radiation injury would be directed toward combating these factors. Once again, the clinician is familiar with the usual procedures used in the management of these factors as seen in other hemorrhagic states. Also familiar to the clinician are the difficulties in attempts to control such hemorrhage.

Finally, the role of infection in this syndrome certainly seems an important one. The factors involved in the etiology of the infections are the severe leukopenia and an impaired ability to produce antibodies.[2,9,10] Again, there is no need to dwell on the conventional treatment of infections from these causes. However, the role of infections in this syndrome should be stressed in view of the fact that in the animals studied at Bikini,[8] and subsequently in this laboratory,[12,15] death did not occur until after the development of a marked elevation of rectal temperatures. This is of considerable interest in view of the fact that Allen, *et al*[10] recently reported the survival for over two months of 2 of 11 dogs treated with aureomycin and blood transfusions after receiving a dose of whole body X-radiation in excess of the LD_{100}.

It would seem that the pancytopenia induced by potentially lethal amounts of radiation is, from the therapeutic standpoint, essentially no different from idiopathic pancytopenia or that induced by drugs or certain infections. There is no obvious reason why the radiation-induced pancytopenia, if temporary, will not respond to conventional treatment as well as the temporary drug-induced pancytopenia, though of course both are very difficult therapeutic problems even under ideal conditions.

The Group III (survival probable) casualties probably will require no active treatment save for reassurance coupled with long term follow-up for possible late sequelae. If any treatment should become necessary in any of these casualties, it would be of the same type as outlined for the Group II casualties.

In summary, there is no simple answer to the treatment of radiation injury, though the use of standard therapeutic procedures directed toward prolonging life until regeneration of radiosensitive tissues begins would seem to be the logical approach of therapy. Under ideal conditions, each casualty would constitute a separate therapeutic problem; and from this brief outline on the nature of radiation injury, one realizes that a number of laboratory procedures involving virtually all phases of medical technology would be of value in the management of any radiation casualty. However, with the very large number of radiation casualties to be expected after an atomic bombing, extensive laboratory study of each casualty almost certainly will not be practicable. Thus clinicians will have to rely on clinical observations and judgment as a substitute for much of this infor-

mation, while those medical technologists available concentrate on a staggering number of but a few of the simpler laboratory procedures that, in the judgment of the clinician, will be of most value in the management of a given casualty.

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REFERENCES

1. LeRoy, G. V., "The Medical Sequelae of the Atomic Bomb Explosion," J.A.M.A., **134**: 1143-1148, 1947.
2. Cronkite, E. P., "The Diagnosis and Treatment of Radiation Sickness in Atomic Warfare," West, J. Surg., **59**: 55-61, 1951.
3. Dunlap, C. E., "Effects of Radiation on The Blood and The Hemopoietic Tissues, Including the Spleen, the Thymus and the Lymph Nodes," Arch. Path., **34**: 562-608, 1942.
4. Henshaw, P. S., "Experimental Roentgen Injury I, II, III, IV; Effects on Tissues and Blood," J. Nat. Cancer Inst., **4**: 477-522, 1944.
5. Lawrence, J. S., *et al.*, "The Effects of Radiation on Hemopoiesis," U.S.A.E.C. Document, MDDC-853, Univ. of Rochester, 1947.
6. Jacobson, L. O., *et al.*, "The Hematological Effects of Total Body X-irradiation in the Rabbit," U.S.A.E.C. Document, MDDC-1174, Univ. of Chicago, 1947.
7. LeRoy, G. V., "Hematology of Atomic Bomb Casualties," Arch. Int. Med., **86**: 691-710, 1950.
8. Cronkite, E. P., "The Hemorrhagic Syndrome of Acute Ionizing Radiation Illness Produced in Goats and Swine by Exposure to the Atomic Bomb at Bikini, 1946," BLOOD, **5**: 32-45, 1950.
9. Cronkite, E. P., "The Diagnosis, Prognosis, and Treatment of Radiation Injuries Produced by Atomic Bombs." RADIOLOGY, **56**: 661-669, 1951.
10. Allen, J. G., *et al.*, "Pathogenesis and Treatment of the Post-irradiation Syndrome," J.A.M.A., **145**: 704-711, 1951.
11. Allen, J. G., *et al.*, "HEPARINEMIA (?) An Anticoagulant in the Blood of Dogs with Hemorrhagic Tendency After Total Body Exposure to Roentgen Rays," J. Exper. Med., **87**: 71-86, 1948.
12. Jackson, D. P., *et al.*, "Further Studies on the Nature of the Hemorrhagic Phase of Radiation Injury," In preparation.
13. Holden, W. D., *et al.*, "Hypothromboplastinemia Following Total Body Irradiation," Proc. Soc. Exper. Biol. & Med., **70**: 553-556, 1949.
14. Rosenthal, R. L., *et al.*, "II. Biological Studies of Radiation Effects; Effects of Total Body X-irradiation on Blood Coagulation in the Rabbit," U.S.E.C. Document, AECU-592 (UCRL-414), 1950.
15. Jackson, D. P., *et al.*, "An Evaluation of the Platelet Role in the Hemorrhagic Phase of Radiation Injury," paper presented to Radiology Section of A.M.A. Convention, June, 1951.

CULTURAL DIAGNOSIS OF BRUCELLOSIS*

By MABLE V. MEEKS, M.S., M.T. (A.S.C.P.)

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Marsdon in 1859 first described the clinical signs of brucellosis. This disease, endemic in the Mediterranean basin, had numerous local names: Malta Fever, Gibraltar Fever, Mediterranean Fever, etc. Bruce, from whom the disease gets its present name, in 1887 isolated the causative organism, M. melitensis, from the spleens of patients who died of Malta Fever. Goats were naturally infected and were plentiful in the area. The second member of the Brucella triad, B. abortus, was isolated by Bang in 1897, from studies on infectious abortion of Danish cows. The trinity was completed by isolation of Br. series from swine by Traum in 1914. Evans in 1918 led to the generic classification of these diseases, by demonstrating the relationship between abortus and melitensis organisms.

Because Brucellosis is today a widespread and disabling disease of raw milk drinkers and animal handlers, it is an important Public Health problem. The diagnosis is frequently difficult to make, due to protean and bizarre symptoms and great variation in immunologic response. Positive culture is unequivocal, but not always easy for the inexperienced technologist to attain. The purpose of this communication is to present reliable procedures that have given best results in my hands, and to recommend bone marrow as the best source from which to cultivate these temperamental and refractory organisms.

MATERIALS AND CULTURE MEDIA EMPLOYED

1. The medium described by Castaneda[1] or a modification thereof was selected as the medium of choice for initial cultivation.

Original formula:	
Bacto Tryptose	2.0 grams
Sodium Chloride	0.5 grams
Sodium Citrate	0.5 grams
Bacto Agar	3.0 grams
Distilled water	100 ml.

The pH of this medium is 6.9 to 7 and needs no adjusting.

Fifteen ml. of medium are placed in 100 ml. flatsided rectangular bottles. The bottles are covered with a cap with a rubber diaphragm center and autoclaved at 15 lbs. for 15 minutes. While the agar is hot, the bottles are placed on the side overnight so that

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the agar firmly sets on one of the narrow side walls forming an even, transparent layer. At the same time tryptose broth is prepared:

Bacto-tryptose	2.0 grams
Sodium Citrate	2.0 grams
Distilled Water	100 ml.

Autoclave at 15 lbs. for 15 minutes.

Using aseptic technic 10 ml. of sterile bacto-tryptose broth are added to each bottle containing agar which has been set. These are then placed in the incubator overnight to test for sterility and later stored in the icebox.

After the surface of the capped bottle is carefully sterilized, the bottle is inoculated through the diaphragm cap using the needle with which blood was collected. Ten ml. of blood, or as much bone marrow as can be conveniently obtained by the doctor are used for inocula. The mixture of blood and/or bone marrow is spread over the agar layer for a moment and the bottle then placed in a candle jar in a vertical position and incubated at 36° to 37° C. Every other day cultures are removed from the jar and broth and blood mixture is allowed to flow over the agar layer and the bottle replaced in the incubator, again in a vertical position. This method not only eliminates the tedious necessity of subculturing to tryptose agar plates every four days, but also lessens the danger of laboratory infection of the worker. Usually colonies will appear about the sixth day or after the third agar inoculation. In some instances, they may be visible as early as four days. Colonies appearing earlier are usually not brucella but contaminants or some causative organism other than brucella. Brucella appears on the agar layer as translucent colonies with a blue-gray tint. They are not unlike Streptococcus faecalis on Tryptose agar.

Cultures should be kept at least 20 days before discarding as negative. It is suggested that before discarding, a portion of each culture be transferred to a sterile centrifuge tube, spun down, supernatant discarded and a loop of sediment be transferred to tryptose agar. If growth has not appeared on these plates in four days, the cultures are reported as negative.

The above medium was subsequently modified by the author by using Tryptose agar and Tryptose broth prepared from dehydrated media. Parallel studies have shown this modification to be equally efficient as the original formula described by Castaneda.[1]

A second modification was made using Trypticase Soy Agar and Trypticase Soy Broth prepared from dehydrated media. Altho both products are recommended and used by some laboratories for the cultivation of brucella, the author does not believe that

it is as efficient as the other two media described. However, sufficient parallel studies have been conducted with this medium for conclusive results.

2. Bacto-Tryptose Agar-dehydrated (Difco).

Prepare according to directions on the bottle and dispense in 100 ml. amounts for preparing thionin and basic fuchsin plates for differentiation of species. Plates without dye may be prepared as needed and used for subcultures.

3. Thionin Plates:

Tryptose Agar (sterilized)	100 ml.
Thionin (1% aqueous solution)	0.1 ml.

Melt previously prepared tryptose agar. Heat a small amount of dye solution in a tube in boiling water for 20 minutes before adding to the agar. Mix dye solution and agar. Pour plates. The plates should be used within two days after being poured because the dye may become reduced in the medium on standing.

4. Basic Fuchsin Plates:

Tryptose Agar (sterilized)	100 ml.
Basic Fuchsin (1% Aqueous soln.)	0.1 ml. (hot)

Prepare as described for Thionin plates. Use within two days. Final dilution of dye is 1 - 100,000. The aqueous solution of basic fuchsin should not be made up in large quantities as the solution deteriorates. A safe rule is to prepare the 1% basic fuchsin fresh each time. Plates will be a dark red rose when the reagent is satisfactory.

It is recommended that all cultures be incubated in a CO_2 jar at 36°-37°. Since dye-plates results constitute the most reliable criterion for species identification, the following schema will be helpful:

Thionin	Basic Fuchsin	CO_2 Needed	Classification
Growth	Growth	Yes	B. melitensis
Growth	No Growth	No	B. suis
No Growth	Growth	Yes	B. abortus

When working with contaminated material (i.e., infected milk) crystal violet may be added to the tryptose agar in final concentration of 1 - 700,000. This may be accomplished by adding 1.4 ml. of 0.1% aqueous crystal violet (certified dye) to a liter of medium.

The use of crystal violet is satisfactory in regions where B. abortus is the common infection. However, according to Huddleston, this concentration of crystal violet may inhibit very low concentrations of Brucella suis.

Generally speaking, the use of crystal violet should not be necessary. With proper precautions, specimens of blood, bone marrow, urines and other materials other than feces can be collected without contaminants.

Since most microorganisms prefer a fresh medium with a moist surface, it is recommended that fresh medium be prepared as required, particularly in laboratories where there are only occasional requests for Brucella studies. All media herein suggested can be easily and quickly prepared. Physicians should be asked to cooperate in withholding therapy until satisfactory and specific media are prepared and an adequate number of various specimens are obtained from the patient.

Finally, it should be emphasized in any discussion of Brucellosis that there is not an inconsiderable risk of laboratory infection. The danger of handling virulent cultures, particularly those freshly isolated, must be impressed upon laboratory assistants and non-technical workers who clean glassware. There should be meticulous sterilization of discarded materials emanating from the bacteriological Laboratory.*

CASE HISTORIES

Four case histories of interest will be discussed. Histories will be limited primarily to patients' chief complaints and pertinent laboratory data. The first two cases have previously been published in another study.[3]

Case # 1. M. A. A 37 year old tube millworker was first admitted to this hospital on Nov. 23, 1946, with a provisional diagnosis of bronchopneumonia. He gave a history of chest pains, chills and fever, starting five days prior to admission. There had been considerable coughing, the cough productive of some yellowish sputum. Two days prior to admission he had had a severe chill lasting 30 to 40 minutes with a temperature following of 105°. Clinical course was characterized by undulating fever of 103° to 104° for four to five days, then relatively normal four to five days, gradually rising again.

Laboratory data was unremarkable except for agglutination and cultural results for Brucellosis.

Agglutination data: (Lederle's Commercial antigen used.)

DATE	DILUTIONS					
	20	40	80	160	320	640
11-26-46	3+	3+	4+	4+	4+	4+
12-11-46	2+	3+	3+	3+	4+	4+
12-31-46	2+	2+	2+	1+	±	0
1- 2-47	2+	2+	2+	1+	±	0
1-14-47	0	0	0	0	0	0

* All dyes and dehydrated media may be obtained from Difco, Inc., Detroit or from Baltimore Biological Laboratory, Inc.

Bottles and diaphragm caps recommended may be obtained from A. S. Aloe and Co.: No. 10210, Blood Culture Bottles, 4 oz. capacity.

Any gallon jar with a fairly large opening and screw cap may be used as a candle jar for CO_2 incubation. Smokeless candles may be obtained from any drug or dime store.

Parallel agglutination studies were sent to the State Laboratory with almost identical results. Negative findings of 1-14-47 were confirmed by them.

Blood Culture data:

Specimen	Date	Medium Employed	Results (CO_2 Incubation)
Blood	12- 1-46	Brain Heart Infusion with agar	Negative after 10 days' incubation.
Blood (10 cc)	12- 1-46	10 cc 4% Sterile citrate	Subcultures to tryptose agar every 4 days remained neg. Discarded 20 days.
Blood (10 cc)	12- 9-49	10 cc 4% Sterile citrate	Positive for Brucella abortus on subcultures after 14 days incubation.
Blood (10 cc)	12- 9-46	10 cc 4% Sterile citrate	Positive for Brucella abortus on subcultures after 12 days.
Clot Cultures	12- 6-46	Sent to State Laboratories	Reported as negative.
Clot Cultures	12-19-46	Sent to State Laboratories	Reported as Positive for B. abortus.

Two urine cultures were negative for B. abortus. No bone marrow nor liver biopsies were received for culture. Treatment with sulphadiazine started 12-25-46.

Macroscopic agglutination using patients' serum and an antigen prepared from organisms cultivated:

Serum Dilution	20	40	80	160	320	640	1280
Results	0	1+	2+	3+	4+	4+	4+

Control: negative.

Discharge diagnosis (1/21/47): Brucellosis, acute, due to Brucella abortus—Improved.

Second admission: Admitted 2/7/50 with provisional diagnosis of bronchopneumonia.

The patient had remained reasonably well during the past three years until the present episode. Symptoms and complaints were similar to previous admission Nov., 1946.

Routine laboratory data was essentially negative except for 11% B.S.P. retention on first liver studies. Later negative. Cold

and heterophile agglutinations were negative. All febrile agglutinations were negative including Brucella agglutinations.

Bacteriological Data:

Specimen	Date	Medium Employed	Results
Blood	2- 8-50	Brain Heart Infusion	No Growth 10 days incubation.
Sternal Bone Marrow	2- 9-50	Castaneda	Good Growth B. abortus—4 days incubation
Urine	12- 9-50	Castaneda	Fair Growth B. abortus—6 days incubation
Blood (2)	2-10-50	Castaneda	Good Growth B. abortus—4 days incubation
Blood	2-11-50	Castaneda	Good Growth B. abortus—4 days incubation
Blood	2-14-50	Modified Castaneda	Good Growth B. abortus—4 days incubation
Blood	2-15-50	Modified Castaneda	Good Growth B. abortus—4 days incubation
Liver Biopsy	2-16-50	Modified Castaneda	Good Growth B. abortus—8 days incubation
Blood	2-16-50	Modified Castaneda	Good Growth B. abortus—4 days incubation

Differentiation of B. abortus was confirmed by the State Laboratories.

All agglutination studies remained negative. High dilutions of serum were made with prozone reaction in mind but with negative results. Microscopic agglutination using patients' serum and an antigen prepared from the organisms cultivated from patients blood was negative in dilutions up to 1:5000.

Patient was treated with aureomycin. All cultures following therapy remained negative for Brucella.

Histopathology:

1. Liver Biopsy 2/14/50: Brucellosis, liver.
2. Liver Biopsy 3/6/50 (After aureomycin therapy): Brucellosis of liver with fatty metamorphosis.
3. Liver Biopsy 4/18/50 (Temporary admission): Brucellosis, liver.

Patient was discharged 3/7/50 with diagnosis of Brucellosis, relapse, acute, due to Brucella abortus.

Case # 2. R. L. T., a 25 yr. old white male entered the hospital on September 14, 1950, with a history of headache of 12 days' duration and drenching night sweats and fever of eight days' duration. He was a milk truck driver and for two months prior to admission had been drinking raw milk from the various "cooleratorS" on the farms. Physical examination on admission was essentially negative. Liver and spleen were palpable and tender.

Routine laboratory data was essentially negative except for a low white count (4,200) and a relative lymphocytosis (60%).

Agglutination studies:

DATE	DILUTIONS										
	20	40	80	160	320	400	620	800	1600	3200	6400
9- 7-50	2+	3+	3+	2+	1+	....	±	(Original report from State Laboratories.)			
9-15-50	2+	3+	3+	2+	....	....	....	....	....	....	....
9-20-50	2+	3+	4+	4+	3+	3+	....	2+	1+	±	0
9-28-50	2+	3+	4+	4+	3+	3+	....	2+	1+	±	0
10- 9-50	2+	3+	4+	4+	3+	2+	....	1+	±	0	0

Cultural data:

Specimen	Date	Medium	Results: (Blood Cultures Were Incubated With and Without CO_2 in Duplicate)
Blood	9-14-50	Castaneda (Modified)	Negative 1 month incubation
Blood	9-15-50	Castaneda (Modified)	Negative 1 month incubation
Sternal Marrow	9-15-50	Castaneda (Modified)	Positive (Brucella) 5 days incubation
Blood	9-16-50	Castaneda (Modified)	Negative 1 month incubation
Liver Biopsy	9-18-50	Castaneda (Modified)	Negative 1 month incubation
Sternal Marrow	9-20-50	Castaneda (Modified)	Positive (Brucella) 6 days incubation
Iliac Crest	9-20-50	Castaneda (Modofied)	Positive (Brucella) 6 days incubation
Urine	9-22-50	Castaneda (Modified)	Negative
Sternal Bone Marrow	10- 1-50	Castaneda (Modified)	Negative (after treatment with aureomycin)

Macroscopic agglutination test using patients' serum and antigen prepared from organisms cultivated:

Serum Dilutions	20	40	80	160	320	640	1280	2560	5120
Results	1+	2+	3+	3+	4+	4+	4+	3+	2+

Organisms were subcultured to dye plates and identified as Br. melitensis as good growth occurred on both Thionin and Carbol Fuchsin plates. Since Br. melitensis had not been found in this state subcultures were repeated with fresh dye plates and more dilute inoculum and organisms this time identified as Br. suis. The State Laboratories confirmed the classification of Br. suis.

Histopathology:

1. Liver biopsy (9/19/50): Acute brucellosis, liver.
2. Liver biopsy (10/6/50): (After aureomycin therapy) Brucellosis of liver with fatty metamorphosis.

Patient was discharged 10/12/50 with a discharge diagnosis of Acute Brucellosis, improved, due to Br. suis.

When referred to the State Laboratories, the State Health Inspector visited the farm where the patient lived. One of the sows had had an abortion the night before the inspection. Cultures were made from fetal and placental tissues and were positive for Brucella suis.

Case #3. D. MacL., a twenty-eight year old male plumber entered the hospital Jan. 12, 1951. His illness dates back to 1945 when he was hospitalized while in France. Illness was characterized by fever, chills, malaise, and generalized aching pain. Since then, he has had episodes of fever, chills, and muscular aching occurring every three months. Episodes would subside spontaneously. His last episode was Jan. 9, 1951. His appetite was poor and he had lost 15 lbs. weight.

His family live on a small farm and raise sheep and poultry. He drinks raw milk but from cows that his family have raised. He slaughters sheep, but presently works as a plumber with frequent loss of time due to illness.

Physical examination essentially negative except for tenderness over spleen and liver. Routine laboratory and X-ray data essentially negative.

Bacteriological data:

Material	Date	Medium	Results
Blood (A.M.)..	1-15-51	Heart Infusion and Trypticase Soy Broth	No growth on subcultures to trypticase agar after 20 days
Blood (P.M.)..	1-15-51	Heart Infusion and Trypticase Soy Broth	No growth 20 days
Blood.....	1-15-51	Castaneda (Modified)	Positive (Br. abortus) 8 days incubation
Blood.....	1-16-51	Castaneda (Modified)	Positive (Br. abortus) 8 days incubation
Bone Marrow..	1-16-51	Castaneda (Modified)	Positive for Brucella in 4 days. Also contaminated with Staphylococci.
Bone Marrow..	1-16-51	Trypticase Soy Broth	Subcultures were negative but culture was heavily contaminated with Staph.
Blood.....	1-16-51	Castaneda (Modified)	Positive (10 days)—picked up by subculture to tryptose agar.
Blood.....	1-17-51	Heart Infusion	No growth 10 days
Blood.....	1-19-51	Castaneda (Modified)	Positive 8 days—Picked up on subcultures.
Liver Biopsy...	1-19-51	Castaneda (Modified)	No growth after 38 days.
Bone Marrow..	1-25-51	Castaneda (Modified)	Positive 12 days—Picked up only on sub culture to tryptose agar.

Organisms identified as Brucella abortus and confirmed by State Laboratories.

Aureomycin therapy started 1/25/51.

Four blood cultures collected at intervals up to three weeks after treatment remained negative.

Agglutination data: (Patients' serum and organisms cultivated.)

Serum Dilutions.....	20	40	80	160	320	640	1280	2560
Results.....	2+	2 +	2+	3+	4+	4+	2+	1+

Controls: negative.

Histopathology:

1. Liver Biopsy 1/22/51: Brucellosis, liver.
2. Liver Biopsy 2/15/51 (After terramycin therapy): Healing Brucellosis, liver.

Discharged Feb. 16, 1951, with diagnosis of Brucellosis, chronic, due to Brucella abortus.

Case #4. W. H. P., a 33 year old white male with occupation of lawyer entered the hospital Feb. 5, 1951, with diagnosis of Brucellosis, chronic. He gave a history of malaise and fever since September, 1946. Bouts came on in the fall lasting eight to 10 days. Since October, he had four episodes of chills and fever.

During that period he was treated by local physician with penicillin, aureomycin, terramycin and chloromycetin without change in course. History of drinking raw milk all his life. The public health inspector visited in home but found no clues.

Patient was afebrile on admission and remained asymptomatic. Two blood cultures and one bone marrow were cultured on Castaneda's medium and sent to the laboratory. As the patient remained afebrile and spleen was less palpable, he was discharged Feb. 12, 1951, as probably adequately treated but instructed to return if the cycle again developed. No treatment was given and no liver biopsies obtained.

Agglutination data (Lederle antigen):

Dilution	20	40	80	160	320
Results	1+	2+	3+	3+	2+

The two blood cultures remained negative for one month. Before discarding, cultures were subcultured to tryptose agar with negative results.

The bone marrow culture was similarly treated. No growth was ever apparent on the agar side of Castaneda's medium, but since the broth portion of the medium appeared slimy, subcultures were made after twelve and sixteen days to tryptose agar. Subcultures made twelve days after incubation were negative. Those made sixteen days after incubation were positive for Br. abortus. Since the patient's serum was not available, serum from Case #2 was used for a macroscopic agglutination test. Results were positive 1:2560.

DISCUSSION

In reviewing the four cases, it becomes apparent that cultures of bone marrow yield the highest percentage of positives. This may be explained by the fact that Brucellosis is one of the diseases which primarily invades the reticulo-endothelial system. These diseases are associated with normal or low white count with relative lymphocytosis and enlargement of the spleen due to retothelial hyperplasia. The organisms tend to be engulfed by the reticulo-endothelial cells of the spleen, bone marrow and liver, and produce lesions in the form of granulomata. This reaction appears to account in part for the latency and chronicity of the infection.

Blood cultures, though not as good as bone marrow, were superior to liver biopsies. Urine cultures are worthwhile in early acute cases but not in chronic cases.

Case #1 presented two particularly interesting facts: one being the increased number of positives on second admission as compared to those obtained on first admission three years previously. At that time the medium employed was 4% sterile sodium citrate. Ten ml. of blood were added to 10 ml of the citrate and subcultures were made every 4 days to tryptose agar. Only two cultures out of a total of six were positive by this method and growth required 12 to 14 days incubation.

On second admission, using Castaneda's medium, growth was apparent in 4 days and all cultures (9) were positive. This may in part be attributed to the fact that antibodies were present in the blood on first admission but could not be demonstrated on second admission. A more likely explanation is that the medium employed on second admission was more efficient in promoting growth of Brucellosis than the simple citrate medium previously employed.

The most striking feature of this case, however, was the inability to demonstrate antibodies at any time on second admission. Smith and Martin[3] make this statement: "Two types of chronic brucellosis can be recognized altho some cases cannot be classified in either category. The hypersensitive type shows evidence of good to excellent antibody production and also a marked degree of allergy. The anergic type typically shows a negative skin test to the organisms, and antibodies in the blood cannot be demonstrated. The diagnosis can be established only by culturing the organisms from the blood, joint fluids, bile, stool or lymph nodes (Poston 1941[4])."

Griffitts (1944)[5] offers an even more stimulating explanation. He believes this inability to demonstrate antibodies in known infected cases is due to an agglutinin—"Blocking" property similar to that found in RH sensitization studies (Wiener, 1944).[6] His methods for demonstrating blocking antibodies are relatively simple and offer an interesting problem for the research-minded technologists.

Altho Case #2 was apparently an acute case, antibodies developed rapidly with positive titer 1:1600. This may account for the negative blood cultures. Clot cultures were not resorted to as the cultures of bone marrow both from the sternum and iliac crest produced abundant growth of Brucella suis.

The fact that this organism on first differentiation studies was mistakenly classified as Brucella melitensis rather than Brucella suis, emphasizes the importance of freshly prepared dyes and dye plates, particularly carbol fuchsin. The amount of inoculum must also be controlled. Very heavy inocula may give misleading results. Since Br. suis produces a particularly slimy growth, it is well to make a suspension of the organisms in tryptose broth

before inoculation of dye plates. It must be recognized, too, that each species contains strains which gradually merge into the other species with respect to dye tolerance.

The last two cases illustrate the latency and chronicity of the infection. Emphasis should be placed on the debilitating effect of the disease as a challenge to the various Public Health departments. Unfortunately because of the multiple sources of the infection which maintain the human disease, the problem of prevention is no longer simply concerned with the eradication of bovine brucellosis and the pasteurization of milk.

SUMMARY

1. Simple and efficient media are described for the initial cultivation of Brucella and differentiation of the species.

2. Bone marrow is recommended as one of the most likely sources of the organisms.

3. Multiple blood cultures are recommended before starting therapy to insure positive findings.

4. Four case histories are briefly outlined with pertinent laboratory data and a discussion of the salient features of each case.

REFERENCES

1. Castaneda, A Practical Method for Routine Blood Cultures in Brucellosis. Proc. Soc. Exp. Bio. & Med. V 64, 1947, Pg. 114.
2. Yesner, R. and Kunkel, P. Preliminary Observations on the Effect of Aureomycin, Terramycin, Tibione, Combined Tibione, and Streptomycin, and Chloromycetin on the Morphology of the Liver in Man. Yale J. Biol. & Med., Vol. 23, No. 4, 299-304, Feb., 1951.
3. Zinsser's Textbook of Bacteriology, Smith & Martin, 9th Ed.
4. Poston, The Technic for the Isolation of Brucella from Human Brucellosis. Jour. of Lab. & Clin. Med. 1941, 26:1961.
5. Griffitts, J. J. Agglutination and an Agglutinin—"Blocking" Property in Serum from Known Cases of Brucellosis. Public Health Rep. 62:865. 1947.
6. Wiener, A. S. A New Test (blocking test) for RH Sensitization. Proc Soc. Exp. Biol. & Med. 56:173-176, June 1944.

* "Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the author are the result of her own study and do not necessarily reflect the opinion or policy of the Veterans Administration."

WHY BELONG

For several years I have felt that the only way for medical technology to assume true professional worth and recognition is through the ethical and diligent scientific efforts of people such as we are. The remarkable improvement in the working conditions, hours, salaries, education, medical recognition, and general over-all improvement in the medical technologist to the ever more scientific type of individual has gone far beyond my expectations.

Many times I have discussed the long debated question, "Why contribute financially to an organization of which a Journal is the only tangible proof of its existence?" It is fair because we all like to "see" something for our money. After three years of active participation in the National as well as in the Kentucky, Illinois, and Tennessee societies, let me assure you that I am far from satisfied with their conscientious efforts—but YOU ARE receiving some very good tangible as well as intangible rewards from your professional organizations.

1. You may now be commissioned in the Armed Forces as a laboratory officer.
2. Your civil service ratings have been under constant pressure toward improvement.
3. The Board of Registry of A.S.C.P. now includes three medical technologists.
4. The A.M.A. and other allied medical groups recognize us (ASMT members) as professionals.
5. Your National and State organizations are consulted in matters pertaining to your professional welfare.
6. YOU may guide your professional standards by submitting questions to be used in qualifying new individuals.
7. You have a Journal and a National convention where you are invited to give out with your pet laboratory trade secrets.
8. You have active and certified State and National professional societies.
9. Legislation, Membership, Constitution and By-Laws, Nominations and Elections, Standards and Studies, Research, Service Fund and Finance, and Education committees are active each in their field to help you by tangible and intangible means, each bent on improving the profession of medical technology. There are other projects being carried out, too numerous to take space or time to list or explain, but there definitely is a planned, cohesive, and guided force working for medical technology.

In our everyday laboratory life it is difficult to feel or see the advantages of membership in an organization. I understand that point clearly. It is for each of us in our Pride of Profession to decide whether or not to become a true contributor to the larger, more unwieldy, but far more powerful architect of the profession of medical technology. The people in the clinical laboratories at home will do more to BUILD the profession of medical technology, but only the State and National societies can GUIDE the professional advancement toward its ultimate probabilities.

The only true foundations for medical technology are in the clinical laboratory, the practice of ethical and constantly improving technical laboratory procedures, and a solidification of the technologists into the allied medical sciences on the basis of their own technical work. No speeches, organization, nor committees are going to supplant nor make unnecessary a firm technical foundation. We need every Registry certified technologist to lend us inspirational, monetary, and numerical support at

this time when we are well on the way toward professional autogeny. What a professional boost a 100% membership would have on the further improvement of medical technology throughout the nation. Believe me, we are fast approaching the time when "Pride of Profession" will take over. We will be much prouder of our membership in a profession which finally gets out of the infant stage and starts to act like a responsible, adult contributor to ethical medical allied science.

Sure as Fate we can strike a blow for our professional societies by enlisting converts to professional technology from those thousands of nonmembers. As a fellow technologist and thrice a delegate to the National convention, I have tried to tell you why I think all certified medical technologists should belong to their professional society. What do you think?

Wade Marsh, Jr., M.T. (ASCP), Chattanooga, Tenn.

THE GAVEL

The echoes of the 1951 Convention are penetrating the country, and soon all of you will have heard reports of the success and brilliance of the meeting at Swampscott. Each year the setting provides us inspiration, and the scientific presentations by noted professional experts give us enthusiasm for greater achievement. This year we had added pleasure in electing Miss Geneva Daland of Boston, Massachusetts, to honorary membership in our society.

The committee appointments and such other duties as accrue have been my chief concern these past weeks. The response to the assignments has revealed the sincere cooperation of medical technologists with their profession and their society. Vocational Recruitment has taken its place with the standing committees; Exhibits are to be handled by a three-member committee: the present chairman, an assistant for training in the job, and the local exhibits chairman of the convention. There will be sixty-three committee members to carry out a full program, in line with the forty-eight chartered societies.

A greater membership is the goal of that committee and a large field of M.T. (ACSP) members is available. With finances, being always of concern, you will be interested to read the breakdown by the 1950-1951 Finance chairman of your $5.00 dues for the expenses of the society; and when you can account for 99.8% of your dues, that is finance. Research and Education are planning for the members, while Legislation is on guard for regulations from the outside. Constitution and By-laws stands ready for your amendments to keep the Articles of the Constitution up to the minute. Looking for new leaders is the job of the Nominations and Elections committee, and Standards and Studies members seek to establish a sound professional standing for us on ethical and economic bases. Recruitment from the student world is our responsibility, and Public Relations is "our best foot forward." Your state presidents have responded to the need for a Public Relations Counsel by offering financial support and building up our financial status by a campaign for increasing membership.

The Northwest states have the special convention committees working for the 1952 meeting in Portland, Oregon; and looking ahead into 1953, Kentucky has plans for Louisville. Each of you, about 5000 members in all, is a "ten-committee" member to bring ASMT into another "biggest" year.

L. B. W.

Joy Holm: In the death of Joy Holm, of the Louisiana State Society of Medical Technologists, president of that society last year, and member of the ASMT Education Committee, last May, our profession has suffered a distinct loss.

Beatrice Allison: The death of Mrs. Beatrice Allison, of the Empire State Association of Medical Technologists, Inc., on August 3, 1951, marked the passing of another of our most active members. She had served both her local (Niagara Frontier) and state societies as president. Her death is a great loss to our profession.

NOMINATIONS AND ELECTIONS COMMITTEE

The Nominations and Elections Committee solicits your suggestions for the offices to be filled at the next annual meeting of the House of Delegates of the American Society of Medical Technologists.

The offices to be filled are that of the President-elect, Secretary and the two members of the Board of Directors. The president-elect becomes the president for the following year and a member of the Board of Directors for the year immediately following the presidency. The term of office for the secretary is for one year and is eligible for a second term. The term of office for the Board of Directors is for three years.

The committee would appreciate having your suggestions for these offices, together with qualifications, previous offices held in state and national society, and any other pertinent information. Candidates must be members in good standing for at least two years and willing to serve, if elected.

This is your opportunity to tell us whom you want as candidates to fill the offices to be vacant. Please consider those in your organization qualified to carry on the affairs of the ASMT and send us your suggestions. You may also suggest persons whom you have met, heard or talked with at our national meeting but who are members of other states. We need your suggestions and your committee is eager to consider those whom you would recommend.

We need YOUR co-operation NOW!! Please may we have your suggestions NOT LATER than December 1st, 1951.

Mrs. Violetta Wakefield, M.T. (ASCP), 1209 North 34th St.,
Ft. Smith, Ark.
Chairman, Nominations and Elections Committee

ANNUAL MEETING A.S.M.T.—1952

June 22 through June 26, 1952, Portland, Oregon. Headquarters to be announced. House of Delegates meeting, Monday, June 23. Annual Banquet, Wednesday, June 25. Miss Mary B. Godfrey, *Gen. Chmn., 2045 North Farragut, Portland 3, Oregon.*

All Technologists intending to write papers for the 1952 convention should notify the program chairman on or before December 1, 1951. **All** manuscripts, whether for awards or otherwise, must be submitted in triplicate to the chairman of the program committee on or before January 15, 1952.—Miss Mary J. Nix, *Program Chairman, 4931 N. E. Glisan, Portland 13, Oregon.*

Any person desiring a panorama picture of those who attended the convention in Swampscott may purchase one for $1.00 at the Fay Foto Service, Inc., 45 West Canton St., Boston, Mass.

MOVIE ON MEDICAL TECHNOLOGY

The film "Medical Technology" produced by the Twin Cities Society of Medical Technologists is available to state or local societies for a loan fee of $1.00. It may be secured from the Audio-Visual Extension Service, 230 Northrup Auditorium, University of Minnesota.

STANDARDIZATION STUDY

The College of American Pathologists announces the organization of a program to improve the efficiency and to increase the uniformity of medical laboratory analyses. At first this program will function primarily in supplying highly standardized and very accurate solutions (dextrose and nitrogen standards) that will enable laboratories to develop and maintain uniformly reliable test solutions in the field of chemical determinations. Other branches of medical laboratory work will soon be included in the scope of activities if present plans are continued.

Improvements in chemical studies of specimens derived from patients in physicians' offices and in hospitals will greatly benefit not only the patient being studied but also the physician and the community. They will aid immensely in establishing more accurate diagnoses and they will enable a more exact control of treatments prescribed for certain diseases.

College members who represent about 80 per cent of all certified pathologists now have a uniform source of standardized, extremely accurate chemical solutions prepared in a manner that is likely not to deteriorate. These solutions can be used to verify the correctness of the individual laboratory stock solution, check the accuracy of personnel in performing a test or can be used as a daily reference standard when determinations are made.

This is the second organized effort of pathologists to increase the efficiency of laboratory determinations. The first improvement, sponsored by the American Society of Clinical Pathologists before the College of American Pathologists was organized, dealt with the complete standardization of the Wassermann test. Up to that time samples of the same blood tested in different laboratories sometimes produced contradictory results. Later the pathologists urged the U. S. Public Health Service to continue the method they evolved.

The KENTUCKY State Society of Medical Technologists will be host on Wednesday, October 3, to a tri-state Seminar on Bacteriology, at the Henry Clay Hotel in Louisville. Technologists from Indiana, Ohio, and Kentucky have been especially invited. Dr. R. H. Weaver, Department Head of Bacteriology, University of Kentucky, will speak on THE BACTERIOLOGICAL ASPECTS OF CIVILIAN DEFENSE (10:00 A.M.), and Dr. Emma Moss, Director of the Department of Pathology, Charity Hospital, New Orleans, La., will discuss THE PRACTICAL HANDLING OF BACTERIOLOGICAL MATERIAL IN THE CLINICAL LABORATORY (2:00 P.M.).

Mary Benedict Clark, Chmn. Education Com.

The University of Minnesota announces a continuation course in Bacteriology for Medical Technologists on October 15 and 16, 1951. The course will be presented at the Center for Continuation Study and will be devoted to problems of the hospital bacteriological laboratory. Considerable emphasis will be placed on laboratory methodology, classification and identification of disease-producing agents, and some emphasis on clinical correlation and application. The visiting faculty member for the course will be Dr. Morris Gordon, Senior Assistant Scientist of the Mycology Laboratory, Communicable Disease Center, U. S. Public Health Service, Chamblee, Georgia. The remainder of the faculty for the course will be made up of members of the staff of the University of Minnesota.

This course is being sponsored by the Minnesota Society of Medical Technologists and given with the financial support of the American Society of Medical Technologists.

The semi-annual meeting of the MASSACHUSETTS Association of Medical Technologists will be held at Stevenson's Restaurant, North Dartmouth, Mass., Oct. 20, 1951. Speakers will be William Freeman, M.D., Pathologist Truesdale Hospital, Fall River, Mass., Newport Hospital, Newport, R. I., Secretary of the N. E. Blood Bank Association, and Assistant Professor of Pathology, B. U. School of Medicine, and Gordon D. Stokes, M.D., formerly of the Mayo Clinic, Rochester, Minn., Medical Staff, Truesdale Hospital, Fall River, Mass.

BLOOD BANK ASSOCIATION

The fourth annual meeting of the American Association of Blood Banks will be held in Minneapolis, Minnesota, October 22-24, 1951, Hotel Nicollet. Advance registration by mail will not be accepted after October 10. To register by mail, contact the office of the Secretary, 3301 Junius St., Dallas 1, Texas.

NATIONAL CONFERENCE TO BE HELD JAN. 27-31

Washington, July 23. Dates of Jan. 27 through 31, 1952, for the 3rd National Conference on the United Nations and the Specialized Agencies, were made public by the U. S. National Commission for UNESCO.

The Conference will be held at Hunter College, New York City.

Information may be obtained from the UNESCO Relations Staff, U. S. Department of State, Washington 25, D. C.

NEW INSTITUTE OF PATHOLOGY

Ground breaking ceremonies for the new Armed Forces Institute of Pathology took place at 3 P.M., July 10, at the Army Medical Center, Washington, D.C.

The $7,250,000 structure will take approximately two years to build, and upon completion will fulfill a long felt need in the field of pathology.

The building will be competely air-conditioned and will provide approximately 200,000 square feet of working space. The scientifically designed laboratories will be equipped with the most modern equipment.

Due largely to the continued efforts of Brigadier General Raymond O. Dart, a medical officer, who served as the Institute's Director from 1946 until his retirement in 1950, present plans have been realized.

Located at 7th and Independence Avenue, Washington, D.C., the Institute occupies a structure built in 1887. Adequate, modern housing was imperative if the services of the Institute were to be maintained at the necessary high standards.

Under the Administration of the Army Surgeon General's Office, the Armed Forces Institute of Pathology is made up of four departments.

The Laboratories of Pathology furnish consultation and diagnosis services on specimens submitted by military and other federal hospitals, medical schools, and civilian hospitals and medical institutions all over the world.

The American Registry of Pathology, operating under the auspices of the National Research Council, conducts comprehensive investigations in specific fields of pathology. All of its materials and records are available to medical officers, graduate and other qualified students, and other professional investigators.

The Medical Illustration Service prepares medical exhibits and material for use in training.

The Medical Museum collects and preserves gross material, instruments and other items of historic medical significance.